

APPENDIX B

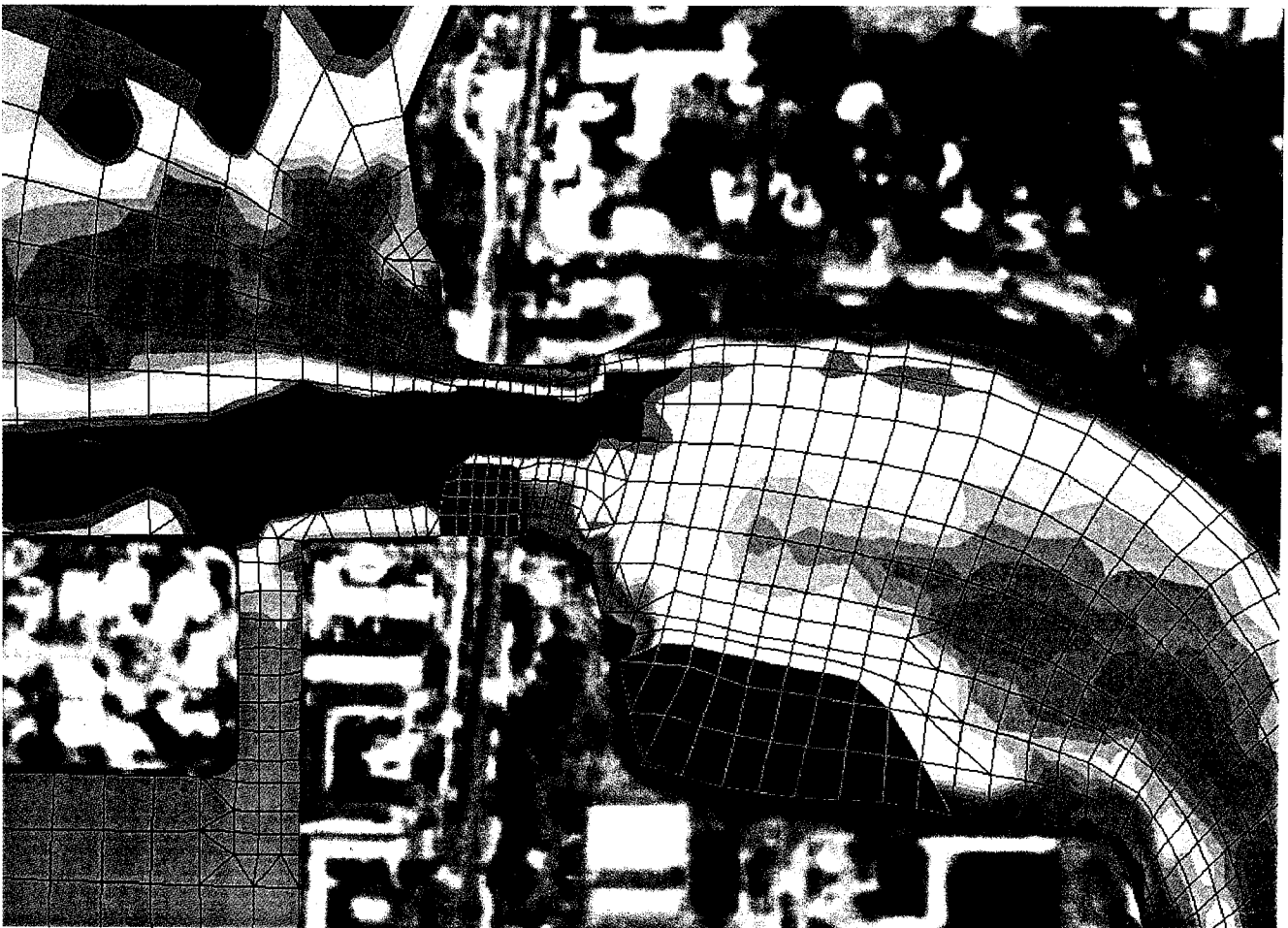
**HYDRODYNAMIC MODEL ALTERNATIVE
ASSESSMENTS**

FOR

**STEVENSON CREEK
CLEARWATER, FLORIDA**

September 2002

**STEVENSON CREEK ENVIRONMENTAL RESTORATION
SECTION 206 FEASIBILITY STUDY
HYDRODYNAMIC MODEL ALTERNATIVE ASSESSMENTS
ENGINEERING SUB-APPENDIX**



DRAFT FINAL REPORT

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PINELLAS COUNTY, FLORIDA**

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NUMERICAL HYDRODYNAMIC MODEL ASSESSMENT
OF STEVENSON CREEK ENVIRONMENTAL RESTORATION
SECTION 206 PROJECT

INTRODUCTION

1. A numerical hydrodynamic model of the Stevenson Creek estuarine system was developed to assess potential improvements to circulation and tidal exchange associated with various project alternatives for the Stevenson Creek Section 206 Environmental Restoration Report. The overall goal of this study is to assess project-related changes in general creek tidal velocity, water surface elevation, circulation, and flow conveyance characteristics to help determine the recommended optimum environmental restoration plan. The base or existing without project condition is used for comparison to other selected alternative conditions associated with the dredged removal of muck sediments (varying mixture of sand and finer-grained materials) within the estuarine portions of Stevenson Creek. The study team has selected elevation -3.5 feet NGVD* as the target depth for the restoration condition in Reach 1 (area between North Fort Harrison Bridge and Pinellas Trail Bridge). In addition to the muck removal and reestablishment of the nominal -3.5-foot depth (2.4 feet below mean lower low water, mllw), several additional structural modifications including additional cross-section opening at North Fort Harrison Bridge and Pinellas Trail Bridge, and additional channelization dredging between Pinellas Trail Bridge and Douglas Avenue Bridge, were assessed with the developed model. Creation of an elevated mangrove shelf at an elevation of +1.0 feet NGVD along the southern shoreline in Reach 1 was also simulated in all models runs except for a sensitivity run undertaken to identify any global shelf-related effects. The final model run and the determined optimum hydrodynamic condition from all alternatives tested includes all geometry (dredging) modifications but without any bridge cross-section alterations.

HYDRODYNAMIC MODEL

2. The finite element numerical model code RMA2 was used along with the Surface Water Modeling System (SMS) during the model development and testing process. RMA2 is a depth averaged hydrodynamic model that uses a finite element approximation method to solve the governing equations of motion and continuity providing solutions of projected water depth, water surface elevation, and velocity magnitude across the modeled area of interest. The reader is referred to the TABS MDS user manual and the SMS user manual for more detailed information regarding the modeling system. A primary underlying constraint of this modeling assessment is that the developed numerical model is solely based on best engineering judgment in the appropriate selection of model coefficients, since field data for model validation (calibration and verification)

*All depths and elevations refer to NGVD 1929 unless otherwise noted

were not available. Therefore, best available model boundary input data, without any rigorous validation beyond an assessment of reasonableness, were used in setting up the hydrodynamic model. This is a result of funding and time constraints and the lack of adequate synoptic hydrodynamic field data, for validation purposes.

BOUNDARY FORCING FUNCTION CONDITIONS

3. The most recent Stevenson Creek hydrographic survey data collected by the Corps of Engineers, between 7 September 2001 and 25 October 2001 (Survey No. 01-196; D.O. File No. 402-38-275), were used in the schematization of the interior portions of the model. Information for the offshore Clearwater Harbor bathymetric schematization was obtained from the August 2001 National Ocean Service Coast Survey Nautical Chart 11411. The model geometry is based on the NGVD 1929 vertical datum. Interior discharge boundary forcing conditions were obtained from Mr. David Jones of Parsons Engineering and are based on long-term average freshwater discharges obtained during the May – November 2000 period of data collection. As recommended, a 1.3 adjustment factor was used to adjust these flows to account for ungauged discharge. A calculated average discharge of 0.3 cfs was initially introduced into the model at the Spring Creek boundary and the average discharge of 2.5 cfs was introduced at the Hammond Creek upstream boundary. Figure 1 illustrates the final developed finite element model mesh for the existing condition. The computation area has been schematized using 5,677 nodes and 1,833 elements. The modeled Spring and Hammond Creek boundaries are also illustrated on this figure. As a result of the low discharge in the Spring Creek system, following preliminary testing, the Spring Creek schematization and discharge were removed from the simulation to improve model stability.

4. An additional inflow boundary condition simulated in the model is the Douglas Avenue Water Treatment Plant discharge located east of Douglas Avenue Bridge. Based on discussions with Mr. Jones, this plant was incorporated in the model with an associated long-term average discharge of 5.6 mgd (million gallons per day) or about 8.7 cfs via an artificial discharge canal (see Figure 1).

5. Tidal boundary conditions were obtained from the X-TIDE software for the DUNEDIN National Ocean Service (NOS) tide station located approximately 1.4 nautical miles north of the mouth of Stevenson Creek. This information was referenced back to NGVD based on the NOS tidal harmonic adjustments between the DUNEDIN and the CLEARWATER tide stations. Based on this information, NGVD is approximately 1.1 feet above mllw at Stevenson Creek. The obtained 4 – 17 April 2002 tidal period of record from the DUNEDIN tide station was used in reproducing the Clearwater Harbor tidal boundary conditions for all model simulations. The first two days of the tidal record were used for model spin-up while the remaining 12-day tidal record was used for alternative flow conveyance assessments. Figure 2 illustrates the Clearwater Harbor forcing

tidal boundary condition reproduced in each of the simulations. The modeling runs were performed using a 15 minute tidal boundary condition update time-step.

MARSH WETTING AND DRYING – MARSH POROSITY

6. Initial conventional model runs were unstable during the low water portions of the tidal cycle. The marsh porosity algorithm in RMA2 was used to allow an improved simulation of the wetting and drying processes across the extensive Stevenson Creek marsh and mudflat areas. This technique allows these wetted areas, at lower water levels, to gradually reduce or increase (dry or wet) the associated element's ability to hold water, similar to squeezing out a sponge. This provides a more realistic simulation of the physical processes associated with the natural marsh wetting and drying phenomenon. The residual water volume across a partially wet element is calculated in the model by vertically integrating a wetted area curve associated with each node. Four parameters are used in the schematization of this process and associated calculations for water surface elevation and velocity are made for each time step of the simulation.

7. Figure 3 provides an illustration of these parameters and their schematization. The depth or elevation of the node, A0, is obtained from the input geometry file, while the other three variables are assigned via marsh porosity input information. For the Stevenson Creek simulations, the minimum distance below the node that allows flow associated with that node location, AC1, was set at 3 feet. AC2 is the transitional wetted tide range during the drying process and was set at 2 feet. Therefore, when the predicted water surface elevation is 1.0 foot above the node (i.e., $A0 + AC2/2$) the model assumes 100 percent of the flow across this area. When the water surface elevation is 1.0 foot below the node (i.e., $A0 - AC2/2$) the model assumes a minimum flow, related to AC3, which was assigned a value of 0.02 (the minimum wetted area of the distribution). During the transition period when the water's surface is either falling or rising between this 2-foot range, a linear reduction in the wetted area controls the amount of water within that region. When the water surface elevation falls 3 feet below the node location, that portion of flow across the element goes to zero, i.e., it dries out completely. This process (Figure 3) allows the element to gradually dry and rewet and helps avoid computational shock, which would result in model instability and potentially erroneous results or a premature end in the simulation.

8. The effective wetted surface area associated with the element will continue to decrease as the depth of additional nodes on the drying element fall below the transition range. If all nodes associated with the element falls below this range (AC1) the complete element would go dry and be eliminated from the simulation. On the incoming tide, as water levels rise, the previously dry element is gradually added back in to the simulation at the specified minimum wetted area, as the predicted water surface elevation rises above the specified rewetting stage at any node. The marsh porosity tool allows the storage of a marsh element to

gradually dry out or rewet reducing model instabilities. It also allows the model to more realistically simulate the physical processes acting within the system.

ALTERNATIVE ASSESSMENTS

9. When developing a numerical model testing program, one needs to carefully select the conditions and combinations of conditions to be assessed since the testing array can quickly grow into something that is too time consuming, expensive, and/or difficult to interpret. A logically devised testing scenario and schedule is almost as important to study results as the modeling boundary forcing conditions. The first alternative condition assessed (Alternative I) in this study effort includes the dredged removal (increased geometric depth) of all materials (muck and sand) above a specified plane and the desired back filling to the prescribed nominal -3.5 foot NGVD depth (2.4 feet below mllw) in Reach 1 between and adjacent to North Fort Harrison Bridge and Pinellas Trail Bridge. It also includes the creation of a raised mangrove shelf at an elevation of +1.0 feet NGVD along the southern shoreline in Reach 1. The same mangrove shelf is included in all following alternatives except for Alternative 7. The Alternative I assessment indicates circulation improvements to be gained with simple restoration and deepening in the western reach (Reach 1) of Stevenson Creek. This is the initial recommended plan from the approved Preliminary Restoration Plan (PRP) report.

10. The second alternative assessed (Alternative II) includes extending the deepened condition as in the first alternative to a nominal -2.5 foot NGVD depth in the area between Pinellas Trail Bridge and Douglas Avenue Bridge (Reach 2) along the thalweg (the primary channel along the longitudinal cross-section and generally the deepest part across the lateral cross-section) in this reach, creating a more efficient and continuous 2.5 foot deep and 30 feet wide channel to further improve circulation, flushing and environmental restoration. This extended dredging condition is compared to both the existing condition and the recommended PRP alternative (Alternative 1). The remaining alternatives addressed through the present modeling effort, with the exception of Alternative 9, all include more costly and time consuming structural alternatives involving either the North Fort Harrison Bridge or both the North Fort Harrison and Pinellas Trail Bridge modifications, in addition to the deepened dredged condition(s).

11. The third alternative (Alternative III) includes dredging just in Reach I along with a new expanded structural bridge opening located just south of the existing North Fort Harrison Bridge. Figure 4 illustrates the proposed expanded North Fort Harrison Bridge modification. This new widened opening will increase this cross-section from 115 feet wide by an additional 135 feet to 250 feet wide. The fourth alternative (Alternative IV) includes the same new North Fort Harrison Bridge opening and also includes muck removal dredging and back filling to the -3.5-foot depth in Reach 1 and the -2.5 foot thalweg deepening in Reach 2. These two alternatives are compared to the existing condition to help quantify

additional incremental project benefits associated with each of these two alternatives associated with the new North Fort Harrison Bridge.

12. The next two alternatives (Alternatives V and VI) assess additional structural bridge modifications at Pinellas Trail Bridge along with the North Fort Harrison Bridge expansion. Figure 5 illustrates the new proposed Pinellas Trail Bridge. The new alternative bridge cross-section at Pinellas will increase this cross-section by 115 feet, from 117 feet wide, to 232 feet wide. Each of these alternative conditions includes dredged deepening in both Reaches 1 and 2. Alternative V includes deepening to a -2.5 feet NGVD thalweg in Reach 2. Alternative VI includes a complete deepening to the -2.5 foot NGVD depth contour throughout Reach 2.

13. Alternative VII is a sensitivity type assessment that examines the influence of the raised mangrove shelf in Reach 1. It reproduces Alternative VI conditions except for the mangrove shelf area that was left at its existing elevation. The last alternative examined (Alternative 9; there is no Alternative 8) also reproduces Alternative VI conditions, but without any modifications to either the North Fort Harrison Bridge or the Pinellas Trail Bridge that are both schematized at their existing configurations. The eight alternatives assessed in this study effort are summarized in Table 1. This table can and should be used as a handy and frequent reference while reading the remainder of this report.

MODEL RESULTS ANALYSES - ALTERNATIVES CHANGE SUMMARY

14. One of the most direct means of analyzing hydrodynamic modeling results is by comparing different alternative model runs conducted with a changed alternative condition to a base condition. The base condition for comparison purposes in this investigation is the model-simulated results from the existing condition model run. Three basic parameters used to quantitatively assess and evaluate hydrodynamic change associated with each of the alternatives include water surface elevation, velocity magnitude, and discharge volume conveyance. Water surface elevation changes are generally the easiest measure to describe and understand, so they are first addressed. Velocity magnitude changes, like water surface elevation changes, are point observations, but are more directly influenced by localized geometry modifications (i.e., depth and/or width changes). Velocity magnitude is more directly influenced by cross-sectional area changes (i.e., $Q = VA$; velocity = volume of flow discharge / area) and is more complex and difficult to understand and explain. Volume discharge conveyance change is closely related to flow duration and velocity magnitude change, but these measurements are based on the total cross-section along a range. This change can be easily summed over any desired and/or specified time-steps and provides a better integration of overall cross-sectional area flow circulation change. It provides an excellent summary means of assessing overall hydrodynamic change between various alternatives and/or conditions.

WATER SURFACE ELEVATION SUMMARY

15. Plates 1 - 64 illustrate the 14-day water surface elevation time-history and 'existing condition minus alternative condition' difference plots for selected locations throughout the interior Stevenson Creek modeled area of interest over the complete simulation period (hours 0 – 336). Figure 6 illustrates the locations of the selected stations and is another reference to have handy while reading this report. As indicated in the time-history and difference plots, the greatest changes between the existing condition and each of the alternative conditions occur during the largest spring tide ranges of the generated 14-day tidal cycle (between hours 200 and 240; i.e., days 8 to 10). Maximum changes are generally associated with the lower water periods of the daily tidal cycle.

16. Results from the eight alternatives are described and summarized by location in the following sub-sections. For clarity and ease of alternative change interpretation, Plates 65 - 128 illustrate a finer scale plot for a portion of the water-surface elevation time-history curve (hours 180 – 240) centered on the spring tide period. These finer scale plots illustrate differences between the base and alternative conditions in greater detail.

17. The difference plots should be carefully studied and analyzed to ensure the proper interpretation because of the procedure and nomenclature used. The secondary y-axis on the right side of the plot provides the associated difference scale that is different than the primary left-axis-scale that is the actual water surface elevation in NGVD. The difference value is determined by the nomenclature 'existing condition minus the alternative condition'. Since elevations below zero NGVD are all negative values, positive difference values during the low water portions of the tidal cycle actually mean that alternative condition water surface elevations are more negative, i.e., low water elevations are further below NGVD than the existing condition. Positive difference values during portions of the tidal cycle above NGVD indicate that the existing condition elevations are larger (higher) than the alternative condition (see below summary 'Water Surface Elevation Differences Nomenclature'). It should also be noted that the largest differences may not necessarily be associated with the lowest water level time-step, and in most cases is offset from that time-step.

18. Table 2 summarizes the maximum predicted high water and maximum predicted low water surface elevations (time step in nearest quarter hour and the predicted elevation ('ACT') in thousandths of feet). The values in the 'DIFF' column summarize the differences between the predicted existing condition maximum high and low water elevations and the maximum predicted alternative condition high and low water elevations ('existing condition minus alternative condition' in nearest hundredths of feet). As mentioned in the previous paragraph, the largest differences between the existing condition and alternative condition do not necessarily coincide with the maximum high and low water

Water Surface Elevation Differences Nomenclature

	When Elevations Are Above NGVD	When Elevations Are Below NGVD
* Existing > Alternative	Difference = +	Difference = -
** Existing < Alternative	Difference = -	Difference = +

* Existing > Alternative means that the existing condition has higher high water or lower low water elevations than the alternative condition

** Existing < Alternative means that the existing condition has lower high water elevations or higher low water elevations than the alternative condition

elevations. Largest differences can be offset from these maximum elevations as a result of the apparent phase shift in the tidal curve between the existing condition and the alternative condition.

19. Table 3 summarizes maximum differences for the period of time where the predicted alternative condition has lower low water conditions relative to the existing condition; i.e., a positive difference value ('existing condition minus alternative condition'). These maximum differences generally occur prior to the lowest low water time step; i.e., the later portion of the falling tidal curve. Table 4 summarizes the opposite condition where the phase shift results in the predicted alternative condition having a higher low water elevation than the existing condition, i.e., a negative difference value, and generally occurs during the following early portion of the rising tidal curve. Maximum elevation differences ('existing condition minus alternative condition') are provided to the nearest hundredths of feet in Tables 3 and 4. The time step associated with the maximum difference (positive value) before the low water is provided in Table 3 while the maximum difference time step following the low water (negative value) is provided in Table 4. The 'time diff' value in each of these tables indicates the time difference between the low water time step and the time step associated with maximum existing condition to alternative condition difference ('low water time step minus maximum difference time step').

20. Subtle to no changes in high water elevation are indicated between alternative conditions at a station or between adjacent stations along Stevenson Creek (i.e., high water elevations generally appear to be unaffected by the tested alternatives). Low water elevation differences are easily detectable between the various alternatives and station locations moving up Stevenson Creek. Low water elevations seem to be somewhat retarded (i.e., not as low, or held back) the further up Stevenson Creek one looks. This is especially true for the existing condition, with a predicted - 1.32-foot maximum low water elevation at North Fort Harrison Bridge and a predicted maximum low water elevation of - 0.69-feet at the Upper Stevenson Creek station. An elevated tidal plan generally exists for all

conditions proceeding up Stevenson Creek. The low water elevations, however, have a tendency to be lower for the higher numbered, generally more progressively modified, alternative conditions (i.e., Alternatives 6, 7, and 9 generally provide the lowest low water conditions). Water level differences between the different alternatives are described in more detail by station in the following sub-sections.

21. NORTH FORT HARRISON: Water surface elevation changes at North Fort Harrison are extremely subtle and well within noise and field detection limits, i.e., largest change from existing condition for any and all alternatives is less than 0.01 feet.

22. MANGROVE SHELF: The mangrove shelf in all alternatives, except Alternative 7 (maintained at existing elevations), is affected by the marsh porosity transition algorithm (part of the wetting and drying process) for all but the higher high tide periods of the simulation. The plots indicate the projected water level as if the shelf did not exist and does not portray the actual surface of the shelf that is fixed at an elevation of +1.0 feet NGVD.

23. PINELLAS TRAIL: A slight low water phase (time of arrival) shift with about a 15 minute earlier time of arrival is indicated at the Pinellas Trail observation location for all examined alternatives. This phase shift is subtle and almost visually nondetectable in the scale of the time-history plots provided although it can be identified in the output data files. At first glance, this phase shift appears to result in an apparent maximum lower low water difference of about 0.04 to 0.05 feet below the existing condition at this location. As evidenced by the differences plot (i.e., 'existing base condition minus alternative condition'), larger positive differences (i.e., alternative low water conditions are lower than existing condition, since low water values are negative values) are indicated prior to the low water and are followed by smaller negative values after low water. These differences are associated with an earlier low-water phase shift indicating a more efficient channel during the lower water portions of the tidal cycle for the alternative conditions.

24. REACH 2: The lower Reach 2 station is located about 450 feet southeast (upstream) of Pinellas Trail Bridge. A similar 15-minute earlier phase shift is indicated for Alternatives 2, 4, 5, 6, 7, and 9 at low water times. The lower low water elevation differences are slightly greater at this location than at the Pinellas Trail location with the maximum apparent differences generally slightly less than 0.1 feet. The most dramatic alternative changes from existing conditions are predicted for Alternatives 6, 7 and 9 with the largest differences approaching 0.1 feet at the lower low water elevation times of the 14-day tidal cycle. Again, this difference is indicated during the lower falling portion of the ebb tidal cycle and appears to be the result of a more efficient channel during low water periods.

25. UPPER REACH 2: The Upper Reach 2 station is located about 490 feet northwest (downstream) of Douglas Avenue Bridge and about 960 feet southeast of (upstream from) the lower Reach 2 station. For existing conditions, the tidal curve during the lower water portions of the ebb tidal cycle appears to be somewhat distorted or truncated away from a sinusoidal shape. This is the first location east of the Stevenson Creek Entrance to illustrate visually detectable alternative water level elevation differences from the existing condition during periods of low water for Alternatives 2, 4, 5, 6, 7, and 9. The more efficient hydraulic conditions associated with these alternatives are clearly illustrated at this location. Alternative low water differences during the larger low tide conditions are close to 0.50 to 0.60 feet lower for these alternatives compared to the existing condition.

26. It is interesting to note that the water level curve becomes more symmetrical for these alternative conditions. No water level differences from existing conditions are indicated for Alternatives 1 and 3 (i.e., these two alternatives do not include any modifications to the Stevenson Creek system above Pinellas Trail Bridge). As indicated by Alternative 3, even modifications to the North Fort Harrison Bridge along with Reach 1 dredging do not appear to have any noticeable influence on water levels above Pinellas Trail Bridge.

27. DOUGLAS AVENUE: The predictions at the Douglas Avenue Bridge station are similar to Upper Reach 2 station predictions with maximum low water elevations around and somewhat deeper than -0.55 to -0.65 feet less than the existing condition for Alternatives 2, 4, 5, 6, 7 and 9. Again, the alternative low water curves are more symmetrical than the existing condition and no water level differences from existing conditions are indicated for Alternatives 1 and 3, including no change to the distorted or truncated low water portion of the curve. Again, the North Fort Harrison Bridge modification (Alternative 3) seems to have no noticeable water surface elevation influence at this location.

28. WETLAND AREA: Model predictions in the wetland area above Douglas Avenue Bridge follow similar trends as the Douglas Avenue Bridge, although alternative low water differences are reduced to about 0.2 feet lower than existing conditions. No water level differences from existing conditions are indicated for Alternatives 1 and 3.

29. UPPER STEVENSON CREEK: Subtle to no differences in water level are indicated for Alternatives 1 and 3. Differences similar to those in between Douglas Avenue and the Wetland Area are indicated at the Upper Stevenson Creek station, located about 775 feet southeast of (upstream from) the Douglas Avenue Bridge. Maximum low water elevation differences for Alternatives 2, 4, 5, 6, 7 and 9 are predicted between 0.4 to 0.5 feet lower than existing conditions.

30. SUMMARY: High water surface elevations do not appear to be influenced or changed (changes on the order of 0.001 feet or less) by any of the alternative

conditions. Only subtle alternative low-water level differences from the existing condition, all within noise and field detection limits, are indicated at the North Fort Harrison Bridge and the Mangrove Shelf locations. A small low water phase shift with about a 15 minute earlier time of arrival is indicated at Pinellas Trail resulting in an apparent trend of maximum lower low water difference of about 0.04 to 0.05 feet. This change appears to be the result of a more efficient channel allowing more ebb flow to exit the upper Stevenson Creek system. Similar but amplified (larger) changes are indicated at stations progressing up Stevenson Creek (i.e., northwest to southeast).

31. Alternative maximum low water elevations and differences from existing conditions at Reach 2 (R2 located approximately 450 southeast of Pinellas Trail Bridge) are close to 0.05 to 0.1 feet for Alternatives 6, 7 and 9 (these alternatives all involve additional dredging in Reaches 1 and 2. Alternative condition differences at Upper Reach 2 (UR2) is the first station to indicate visually detectable changes with alternative lower water surface elevations on the order of 0.5 to 0.6 feet deeper than the existing conditions (Alternatives 2, 4, 5, 6, 7, and 9). UR2 is located an additional 960 feet further southeastward up Stevenson Creek from station R2. The truncated low water portion of the existing condition tidal curve (also for Alternatives 1 and 3) appears more symmetrical for the other alternatives. The largest alternative condition low water elevation differences exist at the Douglas Avenue location, where low water changes as large as 0.55 to 0.65 feet below existing conditions are identified, again for Alternatives 6, 7, and 9. Low water differences are reduced at the Wetland site to about 0.2 feet below existing conditions. Intermediate differences exist at the Upper Stevenson Creek station, with alternative condition maximum low water changes on the order of 0.4 to 0.5 feet lower than existing conditions.

32. Alternatives that involve dredging in both Reaches 1 and 2 (Alternatives 2, 4, 5, 6, 7 and 9) were found to improve overall circulation in Stevenson Creek based on water surface elevation assessments. Alternatives 6, 7, and 9 were found to generally result in the greatest improvements with the lowest low water conditions. The Mangrove Shelf in the sensitivity test (Alternative 7) was found to have minimal influence on water surface elevations away from the immediate shelf area, indicating that this feature is predicted to have minimal to no impact to the overall elevation hydrodynamics in Stevenson Creek. Alternatives 1 and 3 that only include modifications in Reach 1 were also found to have minimal water surface elevation influence from the existing condition. As indicated by the minimal water surface elevation changes between (a) Alternative 1 (Reach 1 dredging only), Alternative 3 (Reach 1 dredging and North Fort Harrison Bridge extension), and the existing condition, and (b) Alternatives 6 and 9 (with and without the cross-sectional expansions associated with the North Fort Harrison and Pinellas Avenue Bridge modifications), bridge modifications have minimal influence on the overall water surface elevation dynamics in Stevenson Creek.

33. Deepening Reach 1 by the removal of the muck materials along with additional dredged deepening in Reach 2 appears to provide the biggest improvements in overall tidal characteristics in Stevenson Creek. Total deepening in Reach 2 seems to enhance this result compared to the smaller thalweg deepening. As indicated by the truncated low water tidal curves, sediments (muck and sand) that have deposited and accumulated over time appear to have constrained and/or slowed (retarded) the normal estuarine circulation. Removal of these sediments appears to restore and improve overall tidal hydrodynamics in Stevenson Creek. Modifications performed only in Reach 1 (Alternatives 1 and 3) provide little influence on and improvement to tidal dynamics in Stevenson Creek.

VELOCITY MAGNITUDE CHANGES

34. Velocity assessment is based on point observations that can be directly influenced by localized geometry changes (depth and/or width changes) that can complicate trends in the data and in their interpretation. With the exception of the North Fort Harrison (NFH) and Upper Reach 2 (UR2) stations, all stations including and downstream (or northwest) of the Douglas Avenue Bridge are directly influenced by alternative depth changes associated with dredging and fill activities. The NFH and UR2 stations maintain their existing elevations, respectively at - 5.2 feet and - 4.18 feet, throughout this study since they are already deeper than desired nominal alternative depths). Depth changes at the other stations include: Mangrove Shelf (MS) existing elevation (ex el) at - 2.69 feet / all alternatives raised and maintained at + 1.0 feet (an exception is Alternative 7 which maintains the existing geometry); Pinellas Trail (PT) ex el at - 1.75 feet / all alternatives at - 3.5 feet; Lower Reach 2 (R2) ex el at - 1.35 feet / all alternatives at - 2.5 feet; and DA ex el at - 1.575 / all alternatives at - 2.5 feet. Elevations at Upper Stevenson Creek (US) at - 1.795 feet and the Wetlands (WL) at +0.618 feet are also maintained throughout all model runs. Alternative cross-section expansions associated with the North Fort Harrison Bridge modification (Alternatives 3, 4, 5, 6, and 7; see Figure 4) and Pinellas Trail Bridge modification (Alternatives 5, 6, and 7; see Figure 5) complicate trends and interpretations since they result in even larger influences on the point velocity observations.

35. Two sets of velocity magnitude plates (similar to the water surface elevation plates) are provided with two different resolution scales. Plates 129 - 192, illustrate the 14-day velocity time-histories and the 'existing condition minus alternative condition' differences at the observation stations (Figure 6) for the complete simulation period (hours 0 - 336). Plates 193 - 256 illustrate a finer scale plot for a portion of the simulation period (hours 180 - 240) centered on the spring tide period. These plots are presented somewhat differently than the water surface elevation plots in that ebb and flood velocity magnitudes are both positive values (no negative magnitudes) and are plotted above the zero-value

along the primary y-axis scale (left side of plate). The ebb and flood tidal cycles can be easily identified since the maximum velocity during each tidal day is always associated with the high ebb current, i.e., Stevenson Creek estuarine system is ebb dominated with respect to velocity magnitude. The secondary y-axis on the right side of the plate provides another separate scale for the differences ('existing condition minus alternative condition') that depends on the magnitude of change at each station.

36. As identified in the plots, with few exceptions (and those are quite small), existing condition velocity magnitudes are generally greater than alternative conditions; i.e., all alternatives generally increase the cross-sectional areas and tend to result in reduced tidal currents relative to existing currents. A marked reduction in the existing condition tidal velocities is also apparent above the Lower Reach 2 location and at the proposed Mangrove Shelf area. These trends are nicely summarized in Tables 5 – 7. Table 5 provides the maximum ebb and flood magnitude for each model simulation for the spring tide condition and provides the time step of the maximum ebb, maximum flood, and the associated time of slack water between max ebb and flood. Table 6 provides a similar listing for the 'existing condition minus alternative condition' magnitude and time differences. Table 7 provides an overall maximum ebb (upper information) and maximum flood (lower information) velocity magnitude summary for each of the alternatives. The following sub-sections describe the velocity assessments by location.

37. NORTH FORT HARRISON: Subtle velocity magnitude changes, less than 0.1 fps, from the existing condition are predicted for Alternatives 1 and 2 (dredging alternatives only). More dramatic changes, closer to 0.2 fps reduced velocity magnitude change is predicted for Alternatives 3, 4, 5, 6, and 7 which all involve North Fort Harrison widening associated with bridge modifications. Each successive alternative is predicted to have small increases (hundredths of fps) above the Alternative 3 condition, but all much less than the existing condition. Alternative 9 (no bridge modifications, only dredging) velocity magnitude conditions are close to existing conditions indicating the velocity changes at this location are more sensitive to bridge associated cross-sectional area changes than by the various dredging alternatives.

38. MANGROVE SHELF: As previously mentioned, existing condition velocity magnitudes over the proposed shelf area are already predicted to be extremely low, below 0.1 fps, so alternative conditions indicate little to no influence on velocity magnitudes in this area. Of course, building this shelf up to the desired +1.0 foot elevation will allow this area to be exposed during more of the tidal cycle promoting mangrove establishment along with related ecological improvements.

39. PINELLAS TRAIL: Two clusters of change are predicted at the Pinellas Trail station. Alternatives 1, 2, 3, and 4 (dredging related changes only, no Pinellas

Trail Bridge modifications) all cluster about a 0.5 fps reduced ebb maximum change and a 0.3 fps reduced flood maximum change relative to the existing almost 1.0 fps maximum ebb velocity and 0.7 fps maximum flood velocity. The second group of velocity magnitude changes is related to cross-section widening associated with the Pinellas Trail Bridge modifications (Alternatives 5, 6, and 7). Maximum ebb velocity is reduced by about 0.75 fps while maximum flood velocity is reduced by approximately 0.5 fps. Alternative 9, which includes the largest amount of dredging in Reach 2, clusters on the high side of the first group, with a close to 0.6 fps and 0.4 fps change, respectively for ebb and flood maximum velocity magnitude from existing conditions. This indicates that velocity magnitude conditions are more strongly influenced by the bridge modifications at this location than the proposed deepening conditions, although some dredging related changes also exist.

40. REACH 2: Two closely related clusters of change are predicted at the Reach 2 station. Alternatives 1, 2, 3, 4, and 5 cluster around the 0.36 fps ebb and 0.22 fps flood maximum velocity magnitude. Change on the order of 0.05 fps or less are indicated from the existing condition for these alternatives. Alternatives 6, 7, and 9, which all include the maximum extent of dredging in Reach 2, each indicate considerably reduced velocities relative to existing conditions with velocity magnitudes of less than 0.1 fps, reduced on the order of 0.3 fps on ebb and about 0.2 fps on flood. As evidenced by Alternative 6 predictions compared with Alternative 9 predictions (with and without bridge modifications), there appears to be no noticeable velocity magnitude influence or impact associated with bridge modifications.

41. UPPER REACHES: As previously reported velocity conditions at the Upper Reach 2 (UR2), Douglas Avenue (DA), Wetlands (WL), and Upper Stevenson Creek (US) stations are all considerably reduced to 0.1 fps or less so detection of changes in these areas are within field detection limits and are rather insignificant (changes less than 0.05 fps).

CONVEYANCE DISCHARGE

42. Total cross-section conveyance discharge (related to flow volume, circulation, and exchange capacity) over specified time steps is an excellent means of detecting and assessing overall circulation changes between existing conditions and examined alternatives. The continuity check routine in RMA-2 was used as a means of examining this parameter. The obtained conveyance values are based on an integration of predicted water surface elevation, bottom elevation, and depth averaged velocity along specified cross-sections. Four cross-sections were selected for these calculations including cross-sections adjacent to North Fort Harrison Bridge (Line 2), Pinellas Trail Bridge (Line 3), Douglas Avenue Bridge (Line 4), and Line 5 located in Reach 2, between Pinellas Trail Bridge and Douglas Avenue Bridge. Each line was selected to include one of the nodes identified as a gage station for easy reference back to

water surface elevation and velocity conditions. Figure 6 presents the station and cross-section locations examined.

43. Plates 257 – 288 illustrate the resulting volume discharge (cubic feet per second, cfs) time history and ‘existing condition minus alternative condition’ difference plots (Q-change) for each of the four lines for the complete simulation period (hours 0 – 336). Positive values along the primary y-axis, by modeling convention in this study, are for the ebb period of the tidal cycle (i.e., outflow) and negative values are for flood portions of the cycle (i.e., southeastward inflow into Stevenson Creek from Clearwater Harbor). The secondary y-axis on the right side of each plate provides the ‘existing condition minus the alternative condition’ (Q-change) differences. Plates 289 – 320 illustrate finer-scale volume discharge time history and difference plots for simulation hours 180 – 240 centered on the spring tidal period. The scales may change between various lines and/or between different alternatives, so the scale values should be viewed carefully on each conveyance plot.

44. Plates 257 – 320 allow visual interpretation of volume discharge changes between alternatives at one cross-section and adjacent cross-sections. Positive differences (‘existing condition minus alternative condition’) for the flood cycle (flood conveyance is a negative value by modeling convention) indicate that the alternative condition is predicted to have an increased flood volume conveyance relative to the existing condition. Negative flood differences indicate that the alternative condition is predicted to have a reduced flood conveyance relative to the existing condition. Positive ebb flow conveyance differences indicate reduced alternative conveyance conditions and negative differences indicate increased alternative ebb conveyance relative to existing conditions. The phase of the tidal cycle (ebb or flood), therefore, is important when interpreting the differences (Q-change) portion of these plates as summarized by the following:

Q-Change Differences Nomenclature

Sign Convention	Flood Cycle	Ebb Cycle
Positive Q-change	Alternative > Existing	Alternative < Existing
Negative Q-change	Alternative < Existing	Alternative > Existing

45. The upper portion of Table 8 provides a cross-section line summary of total ebb and total flood flow discharge conveyance (in total cubic feet per second) for each line and condition over the last 12 days of each simulation; i.e., the last 23 complete ebb-flood (half lunar day) tidal cycles. This summation was performed approximately between hours 48 – 333, although the exact time steps (hours) can vary from location or condition depending on local tidal dynamics (i.e., summation was performed for 23 complete ebb – flood tidal cycles). The lower portion of Table 8 provides an overall model prediction summary as described below.

46. A simple sequential ranking type analysis is used at each cross-section as a means of further categorizing and summarizing differences in conveyance between the existing condition and each of the alternatives examined. The alternative or condition with the highest ebb and flood conveyance for each line was assigned a respective highest rank value of eight. The second highest ebb and flood conveyance for each line was assigned a respective rank value of seven, etc, with the lowest conveyance alternative assigned a respective ebb and flood rank value of one; i.e., a total of eight conditions were ranked accordingly for ebb and flood conveyance. The resulting sequential rank value for each alternative at each line is provided along each row labeled 'ebb order' and 'flood order' in the upper portion of Table 8. The first two rows in the lower overall summary portion of Table 8 labeled 'ebb order sum total' and 'flood order sum total' provide an overall ranking summation over the four lines for the ebb and flood period and allow an overall ebb conveyance summary and a flood conveyance summary for Stevenson Creek. The next to last row in Table 8 provides an overall ranking summary calculated by summing together all ebb and all flood rank values. The bottom line in Table 8 indicates the following final sequential rank order summary with respect to overall circulation flow conveyance (i.e., hydrodynamically, this is the bottom line):

Alt 9 > Alt 6 > Alt 2 > Alt 5 > Alt 4 > Existing > Alt 1 > Alt 3

47. Table 9 provides the 'existing condition minus alternative condition' conveyance differences for each alternative at each line and provides an easy means of summarizing and assessing the actual flow conveyance differences. Table 10 further summarizes these differences as a percent change value (existing condition – alternative condition / existing condition). These three tables (Tables 8, 9, and 10) should be considered together when assessing overall hydrodynamic circulation conveyance impacts associated with the examined alternative conditions on the estuarine portions of Stevenson Creek.

48. The following descriptive conveyance summary is based on the above analysis approach. Again, some natural grouping of values (high - medium - low) is suggested in Table 8. The first grouping includes Alternatives 9 and 6, the two alternatives with the highest overall summation scores indicating that these two alternatives are predicted to provide the overall highest ebb and flood conveyance values and largest degree of circulation and exchange of all conditions. These two alternatives involve the removal of the greatest volume of dredged sediments from the wetted portions of Stevenson Creek (i.e., both Reach 1 and Reach 2 dredged to their greatest widths). Alternative 2 at Line 4 was the only condition and location throughout the modeling effort that was predicted to have an individual conveyance ranking (predicted for the flood phase; see last row in upper portion of Table 8) higher than either Alternative 6 or 9 (i.e., only one occurrence with a rank score of 8).

49. Subtle conveyance differences are predicted between Alternatives 6 and 9, based on this analysis procedure and the raw conveyance values (Tables 8, 9, and 10). Alternative 9 (without any bridge modification or extended cross-sections) had a ranking score of 60, and scored a little higher than Alternative 6 (included both bridge modified/extended cross-sections) with a ranking score of 58. This finding is somewhat surprising, and suggests that the cross-section conveyance in Stevenson Creek is barely or negatively influenced by the bridge modifications and/or that the level of identified difference between Alternatives 6 and 9 may be within model noise and/or analysis approach detection limits.

50. The third highest conveyance alternative with a summation score of 48 was Alternative 2. This alternative also did not include any bridge modifications and included complete dredging in Reach 1 but only the basic thalweg dredging in Reach 2. Alternative 5 includes both bridge related modifications and similar basic dredging related sediment removal as Alternative 2 and was the next highest ranked alternative (fourth largest predicted circulation) with an overall ranking score of 38. Alternative 4, only including North Fort Harrison Bridge modifications and the basic dredging, had the fifth highest predicted circulation ranking with a score of 33. This middle group of three alternatives had rank scores between 48 and 33.

51. The final grouping with the lowest rank scores below 25 included the Existing Condition and Alternatives 1 and 3. Alternatives 1 and 3 were the only two alternatives that only included modifications in Reach 1. It is interesting to note that these were the only two alternatives to consistently have reduced ebb conveyance values relative to the existing condition and were also predicted to have reduced flood values at North Fort Harrison and Douglas Avenue Bridges (see Tables 8 and 9). These findings indicate that alternative modifications performed only in Reach 1 are not predicted to provide the desired circulation improvements to Stevenson Creek. All remaining alternatives included modifications in both Reaches 1 and 2 and were predicted to have increased ebb and flood conveyance relative to existing conditions with three exceptions at Line 2 adjacent to North Fort Harrison Bridge. Small alternative conveyance reductions 1.5-percent or lower relative to existing conditions were indicated for Alternative 4 during ebb and flood and Alternative 5 during flood at Line 2.

52. Figure 7 illustrates the above information pictorially for the ebb and flood conveyance values for each line for the Existing Condition and Alternatives 1 – 6 and 9. The marked flow conveyance reduction proceeding up Stevenson Creek is easily discernable in this figure. Close to a 50 percent reduction in ebb and flood conveyance is illustrated between North Fort Harrison Bridge and Pinellas Trail Bridge. This trend is further reduced to less than 20 percent on ebb (13,000/69,000) and less than 5 percent on flood (2,600/57,000) for the existing condition at the Line 4 Douglas Avenue cross-section.

53. Table 10 provides a final summary means of assessing alternative condition impacts to the flow conveyance and circulation characteristics of Stevenson Creek. The indicated ebb and flood conveyance percent change values are determined by a standard percent change calculation; i.e., ((alternative condition conveyance value – existing condition conveyance value) divided by the existing condition conveyance value times 100) to determine the indicated percentage change values. The flood conveyance percent change values are illustrated in Figure 8 and the ebb conveyance percent change values are illustrated in Figure 9. The grouping or clustering of alternatives is clearly illustrated in these two figures. As previously addressed and indicated, Alternatives 1 and 3 demonstrated consistently reduced ebb conveyance (negative change values) relative to the existing condition at all lines and also reduced flood conveyance at Lines 2 and 4. Very subtle flood increases (around 0.1 percent change) were indicated at Line 5, while increases in flood conveyance, around 17.5 percent increase was predicted at Line 3.

54. The largest percentage changes are indicated for Lines 3 and 5 across the middle reaches of Stevenson Creek where most of the dredging improvements would be performed. Although the greatest conveyance volume exists at the North Fort Harrison cross-section (Line 2), the percentage change at this location is reduced considerably to around +/- 5 percent. In addition to the very low conveyance values at the Douglas Avenue cross-section (Line 4), the percentage change values are again low and around the 0 to 5 percent change value.

55. The marked improvements in circulation flow conveyance across Lines 3 and 5 are well illustrated in Figures 8 and 9. Flood conveyance at Line 3 is increased by over 40 percent for Alternatives 6 and 9, between 25 and 30 percent for Alternatives 2, 4, and 5, and 17.5 percent for Alternatives 1 and 3. Ebb conveyance values at Line 3 are also increased but the increase is reduced to less than 15 percent for Alternatives 6 and 9 and below 5 percent for the other alternatives (Alternatives 2, 4, and 5). Flood conveyance increases above the existing condition at Line 5 are reduced somewhat relative to Line 3, but the increases are still substantial. Increases slightly below 35 percent are predicted for Alternatives 6 and 9 and about 15 percent for Alternatives 2, 4 and 5.

CONCLUSION

56. Alternative 9 provides the optimum restoration plan for Stevenson Creek based on a hydrodynamic and engineering perspective and the above modeling results. Alternative 9 includes the dredged removal of recently deposited muck sediments (varying mixture of sand and finer-grained silts) and any necessary back-filling to achieve a nominal bottom elevation of –3.5 feet between North Fort Harrison Bridge and Pinellas Trail Bridge (Reach 1). It also includes additional dredging between Pinellas Trail Bridge and Douglas Avenue Bridge (Reach 2) to achieve a nominal bottom elevation of –2.5 feet. No negative hydrodynamic impacts are identified with incorporating a mangrove shelf at a nominal +1.0 foot

elevation in Reach 1 adjacent to the southern shoreline. This shelf build-up would permit this area to be exposed during more of the tidal cycle thereby promoting mangrove establishment along with other associated ecological improvements (see Environmental Appendix). The modeling assessments indicate that additional cross-section expansion associated with bridge modifications at North Fort Harrison Bridge and Pinellas Trail Bridge do not provide any further improvements to the overall circulation and exchange characteristics within Stevenson Creek and, therefore, are not recommended.

57. The long-term deposition and accumulation of muck material in the Stevenson Creek system for the existing condition reduces circulation characteristics and retards the typical sinusoidal tidal curve as evidenced by the truncated low water periods for stations above Pinellas Trail. The modeling results indicate that modifications performed only in Reach 1 (Alternatives 1 and 3) would not provide the desired circulation improvements to the Stevenson Creek estuarine system. Intermediate (less than Alternative 9) improvements were identified with a reduced dredging plan associated with the total muck removal dredging in Reach 1 and only dredging along the thalweg (Alternatives 2, 4, and 5) creating a continuous nominal -2.5 feet deep channel between Pinellas Trail Bridge and Douglas Avenue Bridge.

58. Greatest water surface elevation tidal changes from the existing condition are predicted during the larger spring tide periods of the tidal cycle, generally associated with the lower water periods of the tidal cycle. Subtle to no detectable changes in high water elevations are identified between the existing condition and any of the alternatives. Little alternative influence is predicted at the North Fort Harrison and Mangrove Shelf stations. A small alternative phase shift with slightly earlier time of arrival of the low water is indicated at the Pinellas Trail station. This phase shift and lower low water conditions become visually detectable and amplified looking at the stations moving up Stevenson Creek. The largest alternative condition low water elevation differences are predicted at the Douglas Avenue station, where low water changes as large as 0.55 to 0.65 feet deeper than existing conditions changes are indicated for Alternatives 6, 7, and 9. Low water elevation differences are reduced at the Wetland site to about 0.2 feet below existing conditions with intermediate differences predicted at the Upper Stevenson Creek station with maximum low water changes on the order of 0.4 to 0.5 feet lower than existing conditions.

59. Velocity magnitude assessments indicate that existing (reduced) cross-sections associated with both North Fort Harrison and Pinellas Trail Bridges do not induce overall hydrodynamic impacts to circulation within Stevenson Creek. As evidenced by comparisons with and without cross-section widening associated bridge modifications, only localized changes to velocity magnitude are identified with little to no change or impact to overall transport flow conveyance. The increased cross-sectional area related to bridge modifications is balanced by reductions in flow velocity rather than by increases in overall volume transport.

The Stevenson Creek estuarine system appears to be and stays in relative dynamic equilibrium with the exterior tidal boundary forcing and interior geometry conditions and does not appear to be affected by reduced cross-section opening constrictions at the two bridges, i.e., tidal velocities in the existing condition openings are increased allowing the same approximate total volume of flow into and out of Stevenson Creek. The removal of deposited and accumulated muck in Reaches 1 and 2, however, is predicted to improve the overall hydrodynamic efficiency allowing an enhanced flow distribution and an overall improved tidal circulation within Stevenson Creek.

60. Based on the conveyance findings of this numerical modeling investigation, Alternative 9 provides the optimum hydrodynamic restoration plan for Stevenson Creek by creating a more efficient tidal circulation and exchange in Reach 1 between North Fort Harrison Bridge and Pinellas Trail Bridge and even larger enhancements, up to a 35 to 40 percent increase in flood conveyance and up to a 25 percent increase in ebb conveyance in Reach 2 between Pinellas Trail Bridge and Douglas Avenue Bridge. Alternative 9 is the recommended environmental restoration plan based on this hydrodynamic and engineering assessment.

Table 1. Revised Alternatives Summary

ALTERNATIVE	NFH	R1	PT	R2	DA
1		X1a			
2		X1a		X2a	
3	W1	X1a			
4	W1	X1a		X2a	
5	W1	X1a	W2	X2a	
6	W1	X1a	W2	X2b	
7	W1	X1b	W2	X2b	
9		X1a		X2b	

NFH = North Fort Harrison Bridge

PT = Pinellas Trail Bridge

DA = Douglas Avenue Bridge

R1 = Reach 1 Area between NFH and PT

R2 = Reach 2 Area between PT and DA

X1a = Complete R1 deepened to -3.5' NGVD with new mangrove shelf at +1.0'

X1b = Complete R1 deepened to -3.5' NGVD without new mangrove shelf

X2a = Model main thalweg deepened to -2.5' NGVD

X2b = Model complete area deepened to -2.5' NGVD

W1 = Increase NFH cross-section width 135 feet (from 115 feet to 250 feet)

W2 = Increase PT cross-section width 115 feet (from 117 feet to 232 feet)

TABLE 2. MAXIMUM HIGH WATER & LOW WATER ELEVATION SUMMARY											
	TIDE	CONDITION	HOUR	ELEVATION, FT			TIDE	CONDITION	HOUR	ELEVATION, FT	
				ACT	DIFF					ACT	DIFF
NORTH FORT HARRISON						DOUGLAS AVENUE					
	HW	ALL	226.25	1.705	0.00		HW	EX, 1, 2, 3, 4	226.25	1.707	0.00
								5, 6, 7, 9	226.25	1.706	0.00
	LW	EX, 1, 2, 3, 4, 5	233.25	-1.317	0.00						
		6, 7, 9	233.25	-1.318	0.00		LW	EX	235.00	-0.731	
								1, 3	235.00	-0.732	0.00
MANGROVE SHELF								2, 4	233.50	-1.293	0.56
	HW	ALL	226.25	1.705	0.00			5	233.50	-1.295	0.56
								6, 7	233.25	-1.316	0.59
	LW	EX, 1, 3	233.25	-1.317	0.00			9	233.25	-1.315	0.58
		2, 4, 5, 6, 7, 9	233.25	-1.318	0.00						
PINELLAS TRAIL						WETLAND					
	HW	ALL	226.25	1.706	0.00		HW	ALL	226.25	1.707	0.00
	LW	EX	233.50	-1.295			LW	EX	235.25	-0.695	
		1, 3	233.25	-1.317	0.02			1, 3	235.25	-0.696	0.00
		2, 4, 5	233.25	-1.318	0.02			2	235.00	-0.919	0.22
		6, 7, 9	233.25	-1.319	0.02			4	235.00	-0.906	0.21
								5	235.00	-0.907	0.21
REACH 2								6, 7	235.00	-0.913	0.22
	HW	ALL	226.25	1.706	0.00			9	235.00	-0.912	0.22
	LW	EX	233.50	-1.260		UPPER STEVENSON CREEK					
		1, 3	233.50	-1.281	0.02		HW	EX	226.25	1.708	
		2, 4	233.50	-1.309	0.05			1- 9	226.25	1.707	
		5	233.25	-1.311	0.05						
		6, 7, 9	233.25	-1.318	0.06		LW	EX	235.00	-0.694	
								1, 3	235.00	-0.696	0.00
UPPER REACH 2								4	233.75	-1.108	0.41
	HW	EX, 1, 2, 3	226.25	1.707	0.00			5	233.75	-1.109	0.42
		4, 5, 6, 7, 9	226.25	1.706	0.00			6, 7, 9	233.75	-1.126	0.43
								2	233.75	-1.176	0.48
	LW	EX	234.75	-0.810							
		1 & 3	234.75	-0.813	0.00						
		2, 4	233.50	-1.297	0.49						
		5	233.50	-1.299	0.49						
		6, 7, 9	233.25	-1.317	0.51						

TABLE 3. MAXIMUM WATER SURFACE ELEVATION DIFFERENCES FOR LOWEST LOW WATER CONDITION									
LOWEST "EXISTING MINUS ALTERNATIVE CONDITION" WATER SURFACE ELEVATION DIFFERENCES (I.E., POSITIVE DIFFERENCE VALUES; PERIOD PRIOR TO LOW WATER TIME STEP)									
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 9	
PINELLAS TRAIL									
ELEVATION, FT	0.05	0.04	0.05	0.04	0.04	0.04	0.04	0.04	
TIME, HRS	232.25	232.25	232.25	232.25	232.25	232.25	232.25	232.25	
TIME DIFF, HRS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
REACH 2									
ELEVATION, FT	0.05	0.07	0.05	0.07	0.08	0.09	0.09	0.09	
TIME, HR	232.00	232.50	232.50	232.50	232.50	232.25	232.25	232.50	
TIME DIFF, HRS	1.50	1.00	1.00	1.00	0.75	1.00	1.00	0.75	
UPPER REACH 2									
ELEVATION, FT	0.02	0.54	0.02	0.54	0.55	0.58	0.58	0.57	
TIME, HR	230.50	233.25	230.50	233.25	233.25	233.00	233.00	233.00	
TIME DIFF, HRS	4.25	0.25	4.25	0.25	0.25	0.25	0.25	0.25	
DOUGLAS AVENUE									
ELEVATION, FT	0.02	0.61	0.02	0.62	0.62	0.65	0.65	0.65	
TIME, HR	230.50	233.25	230.50	233.25	233.25	233.00	233.00	233.00	
TIME DIFF, HRS	4.50	0.25	4.50	0.25	0.25	0.25	0.25	0.25	
WETLANDS									
ELEVATION, FT	0.01	0.23	0.01	0.22	0.22	0.22	0.22	0.22	
TIME, HR	229.50	235.00	229.50	235.00	235.00	235.00	235.00	235.00	
TIME DIFF, HRS	5.75	0.00	5.75	0.00	0.00	0.00	0.00	0.00	
UPPER STEVENSON CREEK									
ELEVATION, FT	0.02	0.53	0.02	0.46	0.46	0.48	0.48	0.48	
TIME, HR	230.00	233.25	230.00	233.25	233.25	233.25	233.25	233.25	
TIME DIFF, HRS	5.00	0.50	5.00	0.50	0.50	0.50	0.50	0.50	
ELEVATION = elevation at maximum difference ('existing condition minus alternative condition')									
TIME = time step of maximum difference ('existing condition minus alternative condition')									
TIME DIFF, HRS = difference between low water and time step of preceeding maximum difference									

TABLE 4. MAXIMUM WATER SURFACE ELEVATION DIFFERENCES FOR LOWEST LOW WATER CONDITION									
HIGHEST EXISTING MINUS ALTERNATIVE CONDITION WATER SURFACE ELEVATION DIFFERENCES (I.E., NEGATIVE DIFFERENCE VALUES; PERIOD FOLLOWING LOW WATER TIME STEP)									
	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 9	
PINELLAS TRAIL									
ELEVATION, FT	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
TIME, HR	236.50	236.50	236.50	236.50	236.50	236.50	236.50	236.50	236.50
TIME DIFF, HRS	-3.25	-3.25	-3.25	-3.25	-3.25	-3.25	-3.25	-3.25	-3.25
REACH 2									
ELEVATION, FT	-0.02	-0.03	-0.02	-0.03	-0.03	-0.04	-0.04	-0.04	-0.03
TIME, HR	236.50	236.50	236.50	236.50	236.50	236.50	236.50	236.50	236.50
TIME DIFF, HRS	-3.00	-3.00	-3.00	-3.00	-3.25	-3.25	-3.25	-3.25	-3.25
UPPER REACH 2									
ELEVATION, FT	-0.23	-0.11	-0.02	-0.11	-0.11	-0.13	-0.12	-0.12	-0.12
TIME, HR	236.75	236.25	236.75	236.25	236.25	236.25	236.25	236.25	236.25
TIME DIFF, HRS	-2.00	-2.75	-2.00	-2.75	-2.75	-3.00	-3.00	-3.00	-3.00
DOUGLAS AVENUE									
ELEVATION, FT	-0.02	-0.11	-0.02	-0.11	-0.12	-0.13	-0.13	-0.13	-0.13
TIME, HR	236.75	236.25	236.75	236.25	236.25	236.25	236.25	236.25	236.25
TIME DIFF, HRS	-1.75	-2.75	-1.75	-2.75	-2.75	-3.00	-3.00	-3.00	-3.00
WETLANDS									
ELEVATION, FT	-0.02	-0.06	-0.03	-0.06	-0.06	-0.08	-0.08	-0.08	-0.08
TIME, HR	237.50	237.50	237.50	237.50	237.50	237.50	237.50	237.50	237.50
TIME DIFF, HRS	-2.25	-2.50	-2.25	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50
UPPER STEVENSON CREEK									
ELEVATION, FT	-0.02	-0.11	-0.02	-0.11	-0.12	-0.13	-0.13	-0.13	-0.13
TIME, HR	236.75	236.25	236.75	236.25	236.25	236.25	236.25	236.25	236.25
TIME DIFF, HRS	-1.75	-2.50	-1.75	-2.50	-2.50	-2.50	-2.50	-2.50	-2.50
ELEVATION = elevation at maximum difference ('existing condition minus alternative condition')									
TIME = time step of maximum difference ('existing condition minus alternative condition')									
TIME DIFF, HRS = difference between low water and time step of following maximum difference (for alternatives)									

TABLE 5. MAXIMUM EBB AND MAXIMUM FLOOD VELOCITY MAGNITUDE

		EXISTING	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8
NORTH FORT HARRISON										
	MAXIMUM EBB, FPS	0.53	0.48	0.50	0.32	0.33	0.34	0.36	0.38	0.52
	MAXIMUM FLOOD, FPS	0.45	0.42	0.42	0.24	0.24	0.25	0.28	0.30	0.44
	MAX EBB, HR	229.75	229.75	229.75	229.75	229.75	229.75	230.50	230.50	230.25
	SLACK TIME, HR	233.75	233.75	233.50	233.75	233.50	233.50	233.50	233.50	233.50
	MAX FLOOD, HR	236.75	236.75	236.50	236.75	236.00	236.00	235.75	235.75	236.00
MANGROVE SHELF										
	MAXIMUM EBB, FPS	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03
	MAXIMUM FLOOD, FPS	0.06	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.03
	MAX EBB, HR	230.50	229.25	229.25	229.25	229.25	229.25	229.25	230.50	229.25
	SLACK TIME, HR	234.00	233.25	233.25	233.25	233.25	233.25	233.25	233.25	233.25
	MAX FLOOD, HR	236.25	237.25	237.25	237.25	237.25	237.25	237.25	240.00	237.25
PINELLAS TRAIL										
	MAXIMUM EBB, FPS	0.99	0.47	0.50	0.47	0.50	0.16	0.24	0.24	0.42
	MAXIMUM FLOOD, FPS	0.69	0.37	0.35	0.37	0.35	0.14	0.18	0.18	0.31
	MAX EBB, HR	229.50	229.50	229.75	229.50	229.75	230.50	230.75	230.75	230.50
	SLACK TIME, HR	234.75	234.75	234.00	234.25	234.00	234.00	233.75	233.75	233.50
	MAX FLOOD, HR	237.00	237.00	236.75	236.75	236.75	236.75	236.00	236.00	236.00
REACH 2										
	MAXIMUM EBB, FPS	0.36	0.38	0.32	0.38	0.32	0.32	0.07	0.07	0.07
	MAXIMUM FLOOD, FPS	0.22	0.22	0.20	0.22	0.20	0.20	0.04	0.04	0.05
	MAX EBB, HR	231.25	231.25	231.25	231.25	231.25	231.25	231.25	231.25	231.25
	SLACK TIME, HR	235.25	235.00	234.00	235.00	234.00	234.00	233.50	233.50	233.50
	MAX FLOOD, HR	236.75	236.50	236.00	236.50	236.00	236.00	235.50	235.50	235.75
UPPER REACH 2										
	MAXIMUM EBB, FPS	0.10	0.10	0.07	0.10	0.07	0.07	0.06	0.06	0.06
	MAXIMUM FLOOD, FPS	0.05	0.05	0.04	0.05	0.04	0.04	0.03	0.03	0.03
	MAX EBB, HR	229.75	229.50	229.25	229.50	229.25	229.25	229.00	229.00	229.25
	SLACK TIME, HR	235.75	235.75	234.75	235.75	235.00	235.00	234.75	234.75	234.75
	MAX FLOOD, HR	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75
DOUGLAS AVENUE										
	MAXIMUM EBB, FPS	0.22	0.23	0.25	0.23	0.24	0.24	0.20	0.20	0.20
	MAXIMUM FLOOD, FPS	0.12	0.12	0.10	0.12	0.10	0.10	0.09	0.09	0.09
	MAX EBB, HR	229.50	229.50	231.75	229.50	231.75	231.75	231.25	231.25	231.25
	SLACK TIME, HR	236.00	236.00	235.50	236.00	235.50	235.50	235.50	235.50	235.50
	MAX FLOOD, HR	238.00	238.00	238.00	238.00	238.00	238.00	238.00	238.00	238.00
WETLANDS										
	MAXIMUM EBB, FPS	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
	MAXIMUM FLOOD, FPS	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
	MAX EBB, HR	229.00	229.00	229.00	229.00	229.00	229.00	229.00	229.00	229.00
	SLACK TIME, HR	235.25	235.25	235.00	235.25	235.25	235.00	235.00	235.00	235.00
	MAX FLOOD, HR	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75	237.75
UPPER STEVENSON CREEK										
	MAXIMUM EBB, FPS	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05
	MAXIMUM FLOOD, FPS	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.01
	MAX EBB, HR	229.75	229.75	230.75	229.75	230.75	230.75	230.75	230.75	230.75
	SLACK TIME, HR	236.00	236.00	235.25	236.00	235.50	235.50	235.25	235.25	235.25
	MAX FLOOD, HR	236.75	236.75	236.75	236.75	236.75	236.75	236.75	236.75	236.75

TABLE 6. EXISTING MINUS ALTERNATIVE MAXIMUM EBB AND FLOOD VELOCITY MAGNITUDE DIFFERENCES

		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8
NORTH FORT HARRISON									
	MAXIMUM EBB, FPS	0.05	0.03	0.21	0.20	0.19	0.17	0.14	0.01
	MAXIMUM FLOOD, FPS	0.03	0.03	0.21	0.21	0.20	0.17	0.15	0.01
	MAX EBB, HR	0.00	0.00	0.00	0.00	0.00	-0.75	-0.75	-0.50
	SLACK TIME, HR	0.00	0.25	0.00	0.25	0.25	0.25	0.25	0.25
	MAX FLOOD, HR	0.00	0.25	0.00	0.75	0.75	1.00	1.00	0.75
MANGROVE SHELF									
	MAXIMUM EBB, FPS	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	MAXIMUM FLOOD, FPS	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	MAX EBB, HR	1.25	1.25	1.25	1.25	1.25	1.25	0.00	1.25
	SLACK TIME, HR	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
	MAX FLOOD, HR	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-3.75	-1.00
PINELLAS TRAIL									
	MAXIMUM EBB, FPS	0.52	0.50	0.52	0.50	0.83	0.76	0.76	0.58
	MAXIMUM FLOOD, FPS	0.32	0.34	0.32	0.34	0.56	0.52	0.52	0.38
	MAX EBB, HR	0.00	-0.25	0.00	-0.25	-1.00	-1.25	-1.25	-1.00
	SLACK TIME, HR	0.00	0.75	0.50	0.75	0.75	1.00	1.00	1.25
	MAX FLOOD, HR	0.00	0.25	0.25	0.25	0.25	1.00	1.00	1.00
REACH 2									
	MAXIMUM EBB, FPS	-0.01	0.04	-0.01	0.05	0.04	0.30	0.30	0.30
	MAXIMUM FLOOD, FPS	0.00	0.02	0.00	0.02	0.03	0.18	0.18	0.18
	MAX EBB, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SLACK TIME, HR	0.25	1.25	0.25	1.25	1.25	1.75	1.75	1.75
	MAX FLOOD, HR	0.25	0.75	0.25	0.75	0.75	1.25	1.25	1.00
UPPER REACH 2									
	MAXIMUM EBB, FPS	0.00	0.03	0.00	0.03	0.03	0.04	0.04	0.04
	MAXIMUM FLOOD, FPS	0.00	0.01	0.00	0.01	0.01	0.02	0.02	0.02
	MAX EBB, HR	0.25	0.50	0.25	0.50	0.50	0.75	0.75	0.50
	SLACK TIME, HR	0.00	1.00	0.00	0.75	0.75	1.00	1.00	1.00
	MAX FLOOD, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DOUGLAS AVENUE									
	MAXIMUM EBB, FPS	0.00	-0.02	0.00	-0.02	-0.02	0.02	0.02	0.02
	MAXIMUM FLOOD, FPS	0.00	0.02	0.00	0.02	0.02	0.03	0.03	0.03
	MAX EBB, HR	0.00	-2.25	0.00	-2.25	-2.25	-1.75	-1.75	-1.75
	SLACK TIME, HR	0.00	0.50	0.00	0.50	0.50	0.50	0.50	0.50
	MAX FLOOD, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WETLANDS									
	MAXIMUM EBB, FPS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MAXIMUM FLOOD, FPS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MAX EBB, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	SLACK TIME, HR	0.00	0.25	0.00	0.00	0.25	0.25	0.25	0.25
	MAX FLOOD, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UPPER STEVENSON CREEK									
	MAXIMUM EBB, FPS	0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01	-0.01
	MAXIMUM FLOOD, FPS	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01
	MAX EBB, HR	0.00	-1.00	0.00	-1.00	-1.00	-1.00	-1.00	-1.00
	SLACK TIME, HR	0.00	0.75	0.00	0.50	0.50	0.75	0.75	0.75
	MAX FLOOD, HR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 7. MAXIMUM SPRING VELOCITY MAGNITUDE & 'EXISTING MINUS ALTERNATIVE' CONDITION SUMMARY, FPS										
	EXISTING	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 7	ALT 8	
MAXIMUM SPRING EBB VELOCITY MAGNITUDE AND EXISTING CONDITION MINUS ALTERNATIVE CONDITION, FPS										
NORTH FORT HARRISON										
MAXIMUM EBB, FPS	0.53	0.48	0.50	0.32	0.33	0.34	0.36	0.38		0.52
EX - ALT, FPS		0.05	0.03	0.21	0.20	0.19	0.17	0.14		0.01
MANGROVE SHELF										
MAXIMUM EBB, FPS	0.08	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.03
EX - ALT, FPS		0.05	0.05	0.05	0.05	0.05	0.05	0.05		0.05
PINELLAS TRAIL										
MAXIMUM EBB, FPS	0.99	0.47	0.50	0.47	0.50	0.16	0.24	0.24		0.42
EX - ALT, FPS		0.52	0.50	0.52	0.50	0.83	0.76	0.76		0.58
REACH 2										
MAXIMUM EBB, FPS	0.36	0.38	0.32	0.38	0.32	0.32	0.07	0.07		0.07
EX - ALT, FPS		-0.01	0.04	-0.01	0.05	0.04	0.30	0.30		0.30
UPPER REACH 2										
MAXIMUM EBB, FPS	0.10	0.10	0.07	0.10	0.07	0.07	0.06	0.06		0.06
EX - ALT, FPS		0.00	0.03	0.00	0.03	0.03	0.04	0.04		0.04
DOUGLAS AVENUE										
MAXIMUM EBB, FPS	0.22	0.23	0.25	0.23	0.24	0.24	0.20	0.20		0.20
EX - ALT, FPS		0.00	-0.02	0.00	-0.02	-0.02	0.02	0.02		0.02
WETLANDS										
MAXIMUM EBB, FPS	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04		0.04
EX - ALT, FPS		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
UPPER STEVENSON CREEK										
MAXIMUM EBB, FPS	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05		0.05
EX - ALT, FPS		0.00	-0.01	0.00	-0.01	-0.01	-0.01	-0.01		-0.01
MAXIMUM SPRING FLOOD VELOCITY MAGNITUDE AND EXISTING CONDITION MINUS ALTERNATIVE CONDITION, FPS										
NORTH FORT HARRISON										
MAXIMUM FLOOD, FPS	0.45	0.42	0.42	0.24	0.24	0.25	0.28	0.30		0.44
EX - ALT, FPS		0.03	0.03	0.21	0.21	0.20	0.17	0.15		0.01
MANGROVE SHELF										
MAXIMUM FLOOD, FPS	0.06	0.03	0.03	0.03	0.03	0.03	0.03	0.04		0.03
EX - ALT, FPS		0.03	0.03	0.03	0.03	0.03	0.03	0.03		0.03
PINELLAS TRAIL										
MAXIMUM FLOOD, FPS	0.69	0.37	0.35	0.37	0.35	0.14	0.18	0.18		0.31
EX - ALT, FPS		0.32	0.34	0.32	0.34	0.56	0.52	0.52		0.38
REACH 2										
MAXIMUM FLOOD, FPS	0.22	0.22	0.20	0.22	0.20	0.20	0.04	0.04		0.05
EX - ALT, FPS		0.00	0.02	0.00	0.02	0.03	0.18	0.18		0.18
UPPER REACH 2										
MAXIMUM FLOOD, FPS	0.05	0.05	0.04	0.05	0.04	0.04	0.03	0.03		0.03
EX - ALT, FPS		0.00	0.01	0.00	0.01	0.01	0.02	0.02		0.02
DOUGLAS AVENUE										
MAXIMUM EBB, FPS	0.12	0.12	0.10	0.12	0.10	0.10	0.09	0.09		0.09
EX - ALT, FPS		0.00	0.02	0.00	0.02	0.02	0.03	0.03		0.03
WETLANDS										
MAXIMUM FLOOD, FPS	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08		0.08
EX - ALT, FPS		0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00
UPPER STEVENSON CREEK										
MAXIMUM FLOOD, FPS	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01		0.01
EX - ALT, FPS		0.00	0.01	0.00	0.01	0.01	0.01	0.01		0.01

TABLE 9. STEVENSON CREEK EBB AND FLOOD CONVEYANCE DIFFERENCES (EXISTING MINUS ALTERNATIVE) SUMMARY

		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 9
LINE 2 - NORTH FORT HARRISON								
	EBB DIFF	-1,792,800	159,300	-2,535,300	-729,900	83,700	3,145,500	4,216,500
	FLOOD DIFF	-1,790,100	138,600	-2,592,900	-838,800	-38,700	2,988,000	3,709,800
LINE 3 - PINELLAS TRIAL								
	EBB DIFF	-738,900	774,900	-737,100	643,500	1,170,000	4,206,600	4,083,300
	FLOOD DIFF	3,359,700	4,920,300	3,357,900	4,806,000	5,201,100	8,124,300	7,919,100
LINE 5 - RANGE 2								
	EBB DIFF	-22,500	3,898,800	-29,700	3,769,200	3,862,800	7,209,000	7,220,700
	FLOOD DIFF	15,300	2,831,400	11,700	2,709,900	2,679,300	5,798,700	5,810,400
LINE 4 - DOUGLAS AVENUE								
	EBB DIFF	-29,700	983,700	-30,600	933,300	927,000	990,900	989,100
	FLOOD DIFF	-17,100	164,700	-19,800	104,400	104,400	148,500	153,900
		ALT 1 = R1		ALT 3 = R1 + NFH		ALT 9 = R1 + NFH + PT + R2 _{TOTAL}		
		ALT 2 = R1 + R2 _{THALWEG}		ALT 4 = R1 + NFH + R2 _{THALWEG}		ALT 5 = R1 + NFH + PT + R2 _{THALWEG}		
						ALT 6 = R1 + NFH + PT + R2 _{TOTAL}		

TABLE 8. STEVENSON CREEK PREDICTED EBB AND FLOOD CONVEYANCE (VOLUME DISCHARGE) SUMMARY INFORMATION								
	EXISTING	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 9
LINE SUMMARY								
LINE 2 - NORTH FORT HARRISON								
EBB ORDER	4	2	6	1	3	5	7	8
EBB	69,224,400	67,431,600	69,383,700	66,689,100	68,494,500	69,308,100	72,369,900	73,440,900
FLOOD	-57,586,500	-55,796,400	-57,725,100	-54,993,600	-56,747,700	-57,547,800	-60,574,500	-61,296,300
FLOOD ORDER	5	2	6	1	3	4	7	8
LINE 3 - PINELLAS TRIAL								
EBB ORDER	3	1	5	2	4	6	8	7
EBB	34,628,400	33,889,500	35,403,300	33,891,300	35,271,900	35,798,400	38,835,000	38,711,700
FLOOD	-19,193,400	-22,553,100	-24,113,700	-22,551,300	-23,999,400	-24,394,500	-27,317,700	-27,112,500
FLOOD ORDER	1	3	5	2	4	6	8	7
LINE 5 - RANGE 2								
EBB ORDER	3	2	6	1	4	5	7	8
EBB	27,237,600	27,215,100	31,136,400	27,207,900	31,006,800	31,100,400	34,446,600	34,458,300
FLOOD	-16,982,100	-16,997,400	-19,813,500	-16,993,800	-19,692,000	-19,661,400	-22,780,800	-22,792,500
FLOOD ORDER	1	3	6	2	5	4	7	8
LINE 4 - DOUGLAS AVENUE								
EBB ORDER	3	2	6	1	5	4	8	7
EBB	13,103,100	13,073,400	14,086,800	13,072,500	14,036,400	14,030,100	14,094,000	14,092,200
FLOOD	-2,626,200	-2,609,100	-2,790,900	-2,606,400	-2,730,600	-2,730,600	-2,774,700	-2,780,100
FLOOD ORDER	3	2	8	1	5	4	6	7
ALTERNATIVE SUMMARY								
	ALT 1 = R1		ALT 3 = R1 + NFH		ALT 9 = R1 + NFH + PT + R2 _{TOTAL}			
	ALT 2 = R1 + R2 _{THALWEG}		ALT 4 = R1 + NFH + R2 _{THALWEG}		ALT 5 = R1 + NFH + PT + R2 _{THALWEG}			
					ALT 6 = R1 + NFH + PT + R2 _{TOTAL}			
OVERALL SUMMARY								
EBB ORDER SUM TOTAL	13	7	23	5	16	20	30	30
FLOOD ORDER SUM TOTAL	10	10	25	6	17	18	28	30
FINAL ORDER SUM TOTAL	23	17	48	11	33	38	58	60
FINAL OVERALL RATING	3	2	6	1	4	5	7	8

TABLE 10. STEVENSON CREEK EBB AND FLOOD CONVEYANCE PERCENT CHANGE* SUMMARY INFORMATION

	EXISTING	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6	ALT 9
LINE 2 - NORTH FORT HARRISON								
	EBB %	-2.6%	0.2%	-3.7%	-1.1%	0.1%	4.5%	6.1%
	FLOOD %	-3.1%	0.2%	-4.5%	-1.5%	-0.1%	5.2%	6.4%
LINE 3 - PINELLAS TRAIL								
	EBB %	-2.1%	2.2%	-2.1%	1.9%	3.4%	12.1%	11.8%
	FLOOD %	17.5%	25.6%	17.5%	25.0%	27.1%	42.3%	41.3%
LINE 5 - RANGE 2								
	EBB %	-0.1%	14.3%	-0.1%	13.8%	14.2%	26.5%	26.5%
	FLOOD %	0.1%	16.7%	0.1%	16.0%	15.8%	34.1%	34.2%
LINE 4 - DOUGLAS AVENUE								
	EBB %	-0.2%	7.5%	-0.2%	7.1%	7.1%	7.6%	7.5%
	FLOOD %	-0.7%	6.3%	-0.8%	4.0%	4.0%	5.7%	5.9%
		ALT 1 = R1		ALT 3 = R1 + NFH		ALT 9 = R1 + NFH + PT + R2 _{TOTAL}		
		ALT 2 = R1 + R2 _{THALWEG}		ALT 4 = R1 + NFH + R2 _{THALWEG}		ALT 5 = R1 + NFH + PT + R2 _{THALWEG}		
						ALT 6 = R1 + NFH + PT + R2 _{TOTAL}		
* Determined by calculation (Alternative Conveyance - Existing Conveyance) / Existing Conveyance x 100								



Figure 1. Stevenson Creek Finite Element Mesh Containing 1,833 Elements and 5,677 Nodes

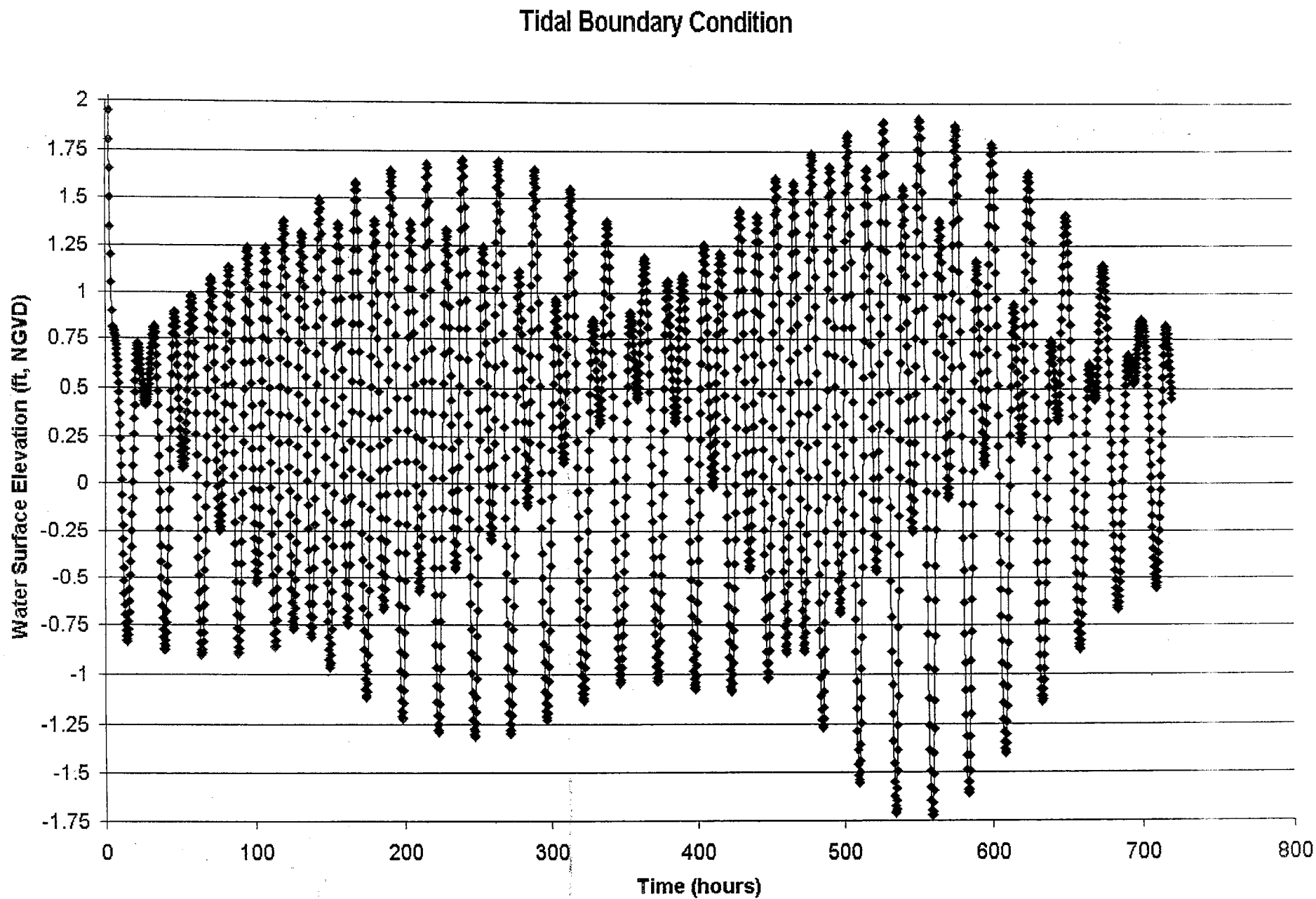
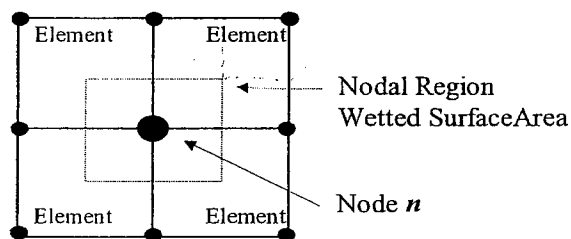
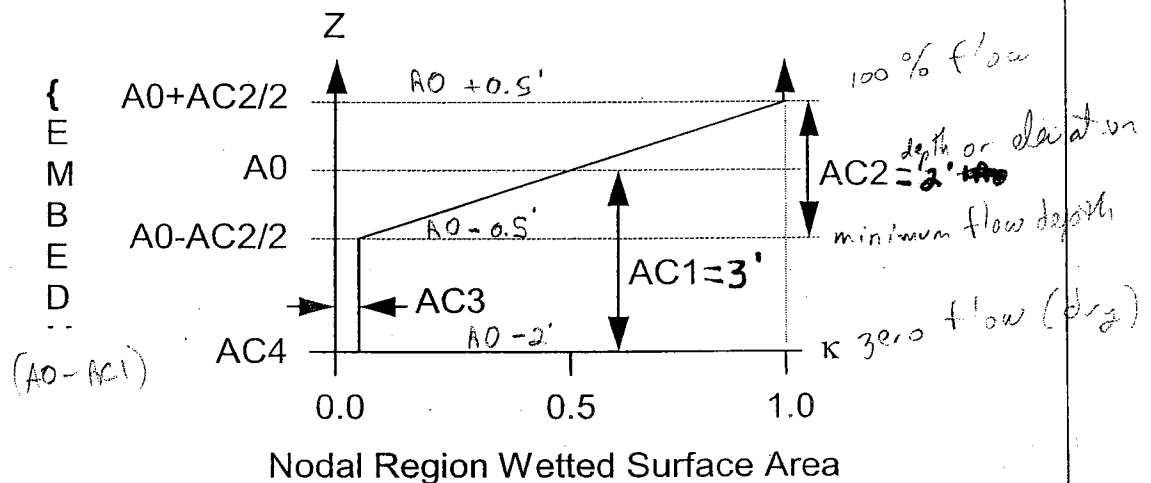
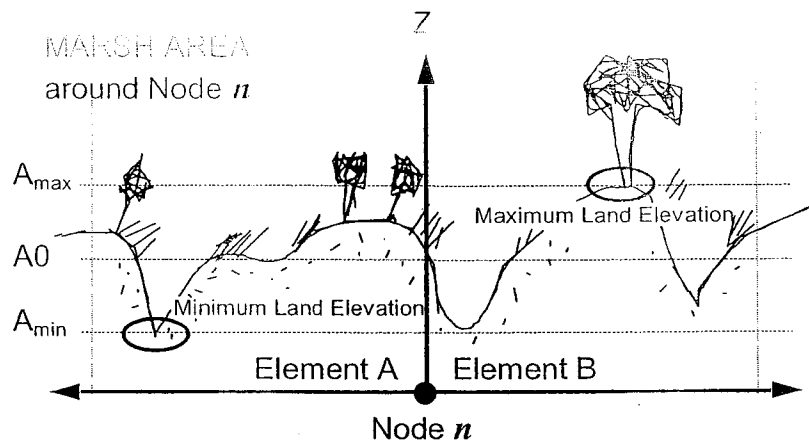


Figure 2. Stevenson Creek Boundary Forcing Tide Condition (Hours 0 – 336 Run)



Where:

- A_0 = average nodal area bed elevation ('z' value from GFGEN GNN Card). A_0 is the mean land elevation in the vicinity of node n .
- AC_1 = distance from A_0 to minimum regional bed elevation.
- AC_2 = transition range of the distribution.
- AC_3 = minimum wetted area of the distribution.
- AC_4 = minimum regional bed elevation.

"Regional" refers to the "nodal area"; the area in the immediate vicinity of node n .

Figure 3. Schematization for RMA-2 Marsh Porosity Wetting and Drying Algorithm (From RMA-2 Users Manual)

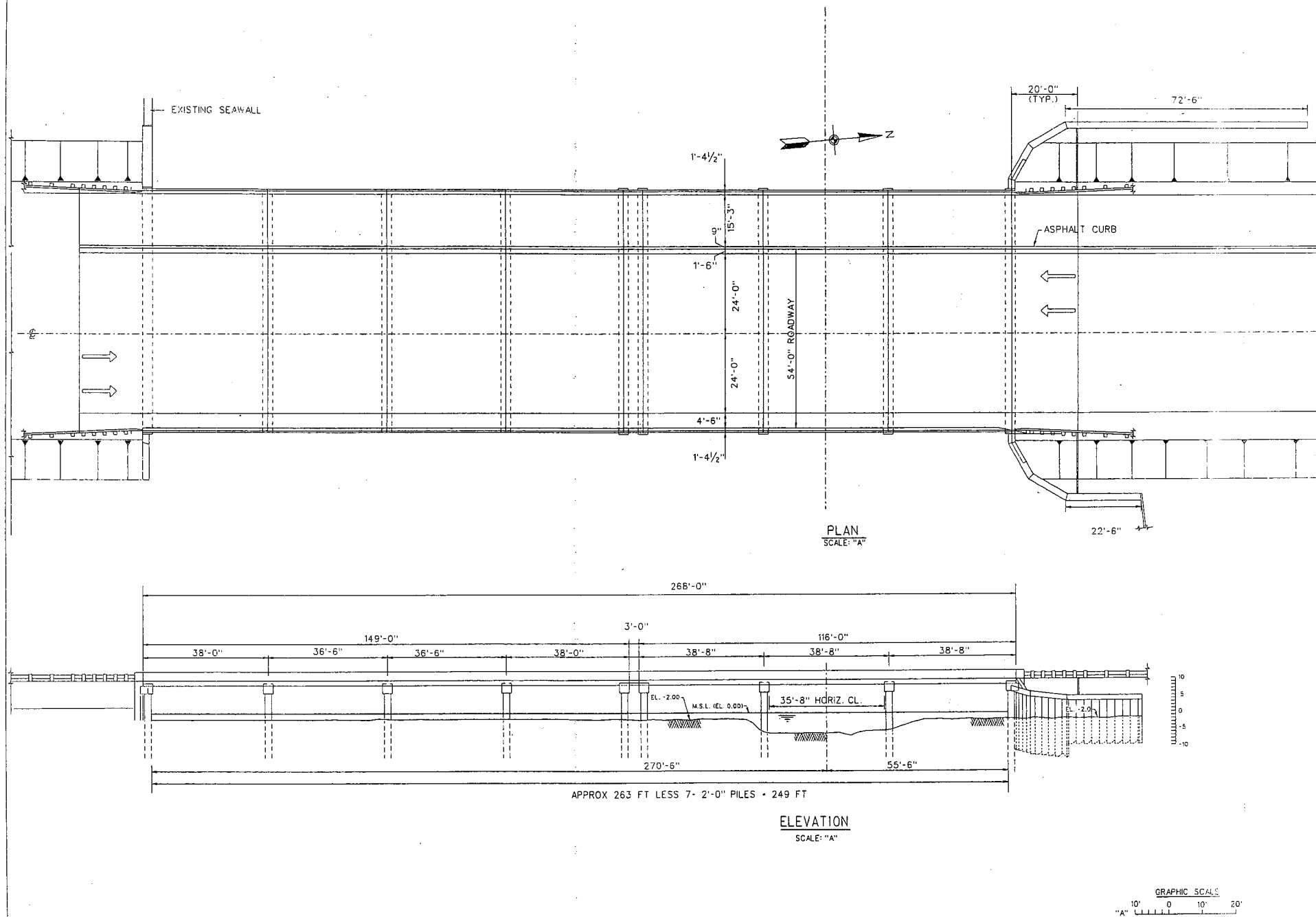


Figure 4. Proposed Expanded North Fort Harrison Bridge Construction Alternative

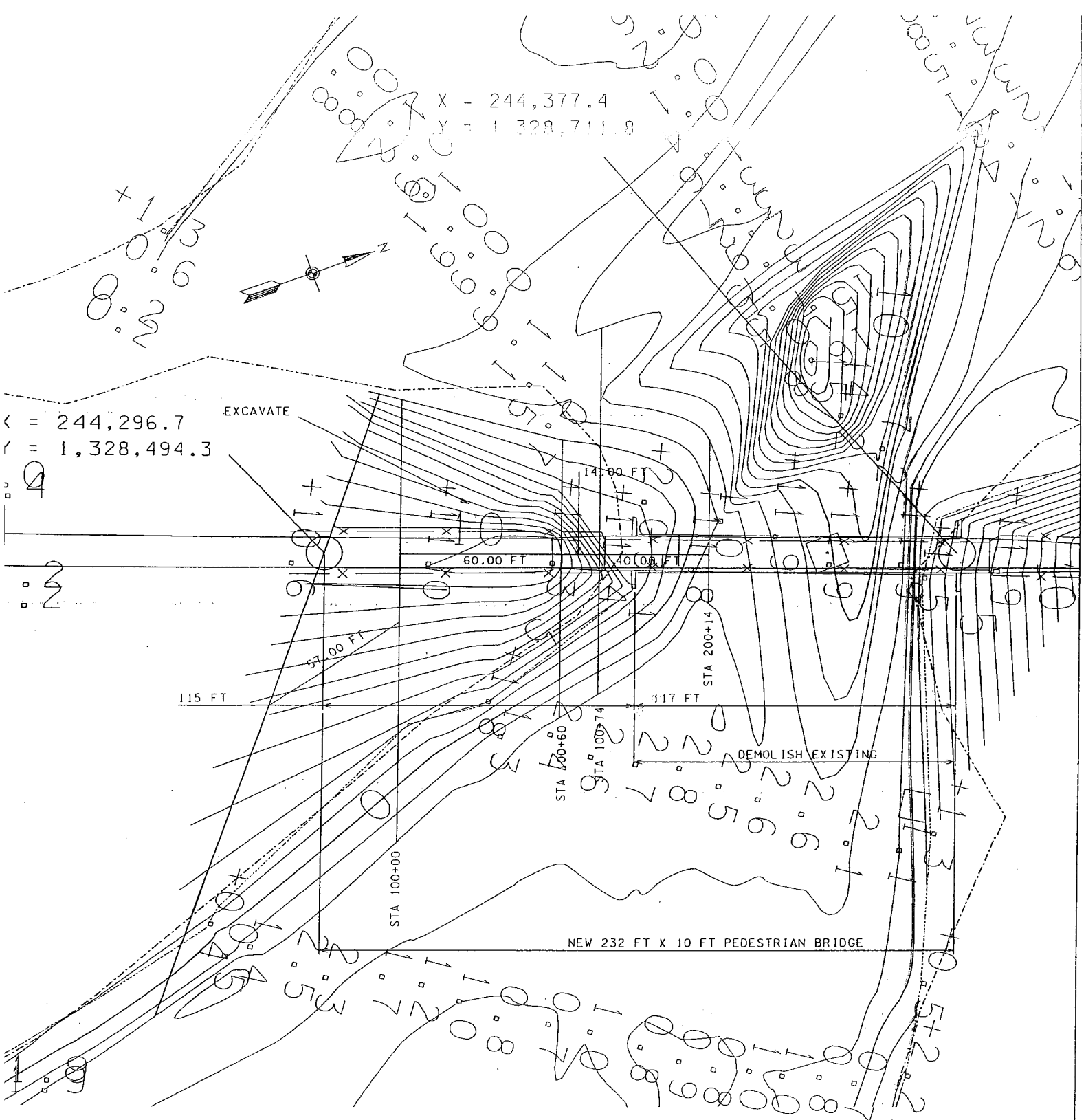
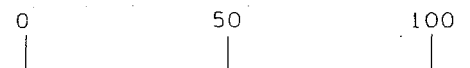


Figure 5 Proposed Pinellas Trail Bridge Construction Alternative



8 MAY 2002

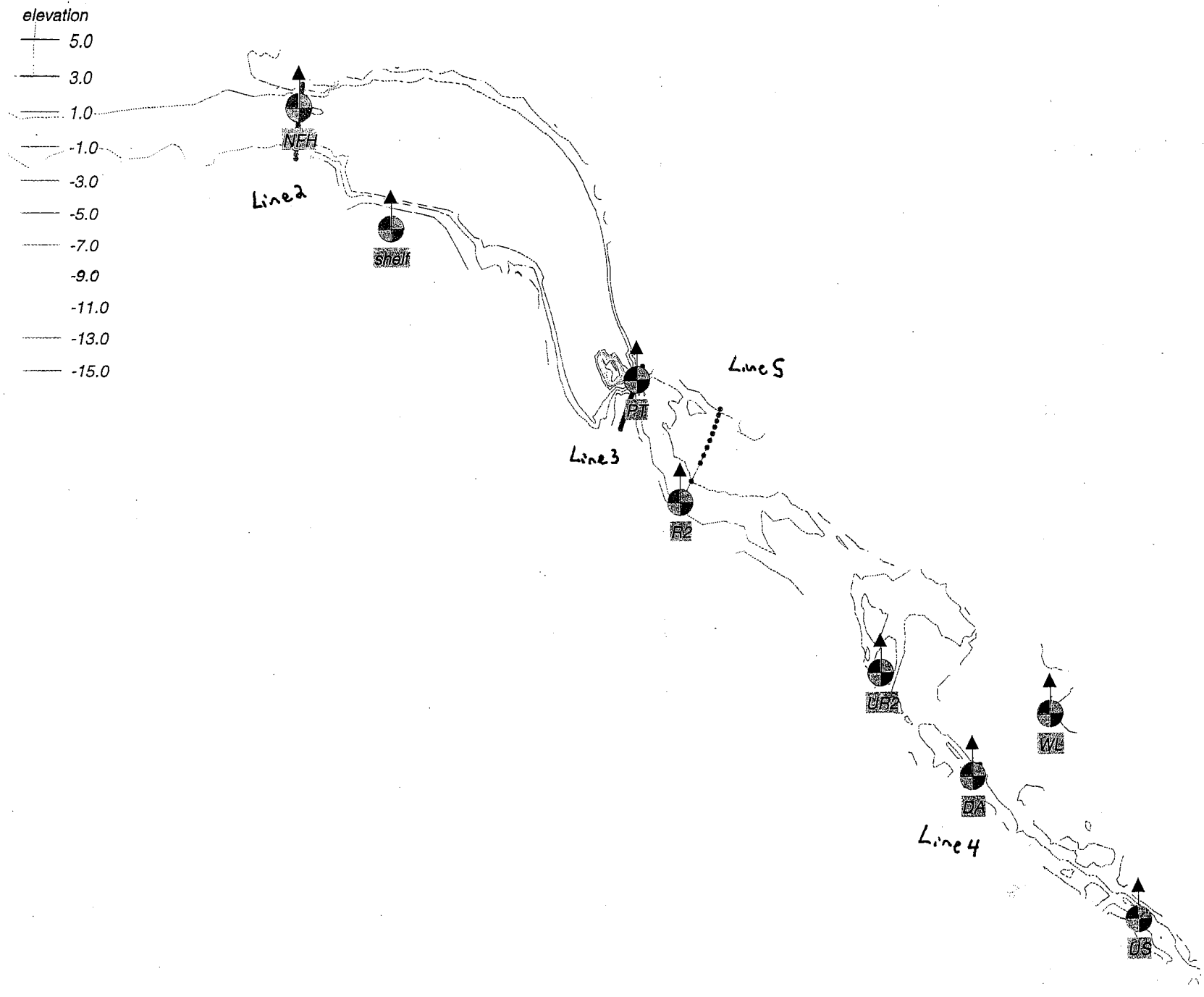


Figure 6. Stevenson Creek Station and Volume Discharge Cross-Section Locations

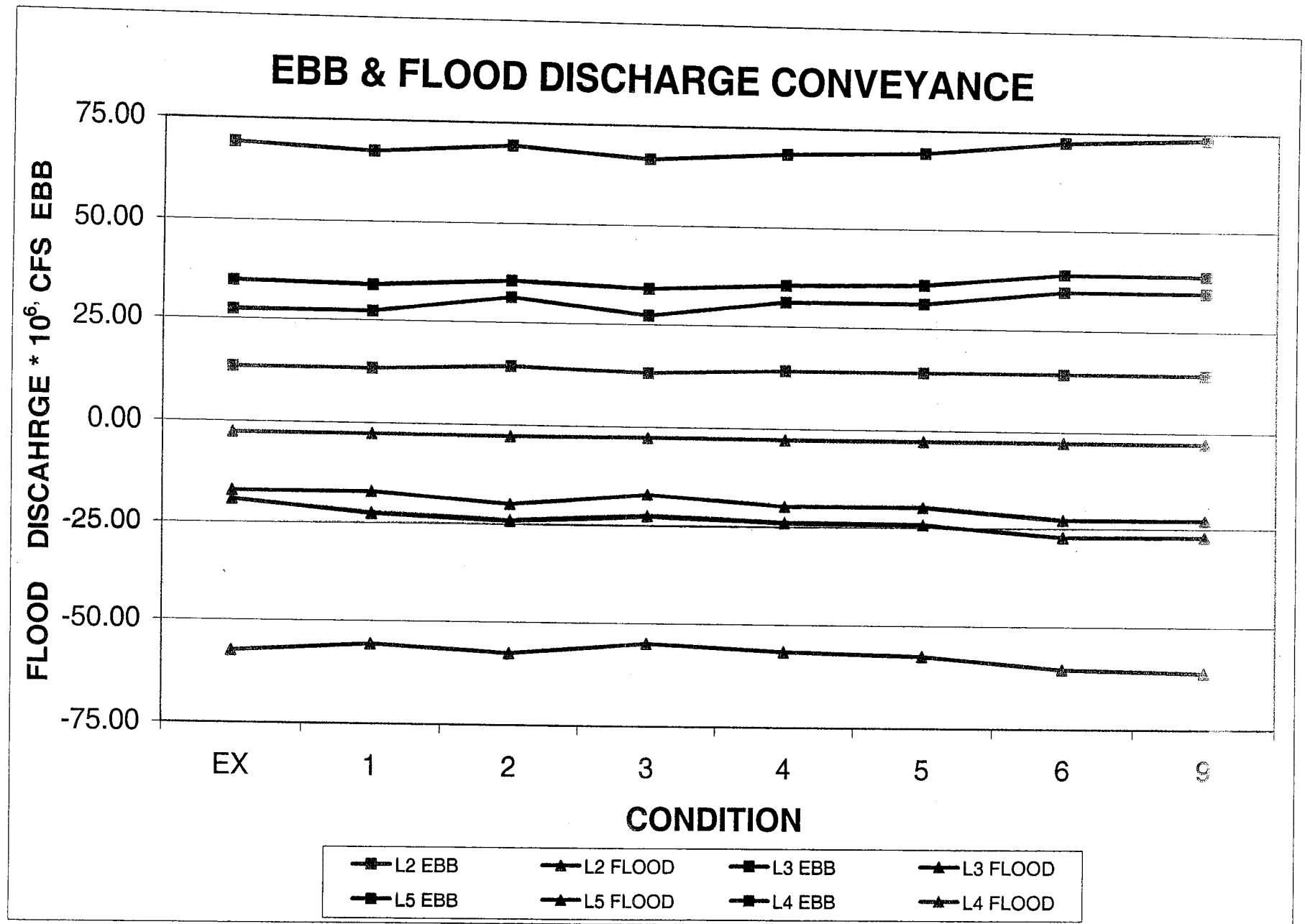


FIGURE 7. EBB AND FLOOD DISCHARGE CONVEYANCE SUMMARY

FLOOD CONVEYANCE PERCENT CHANGE

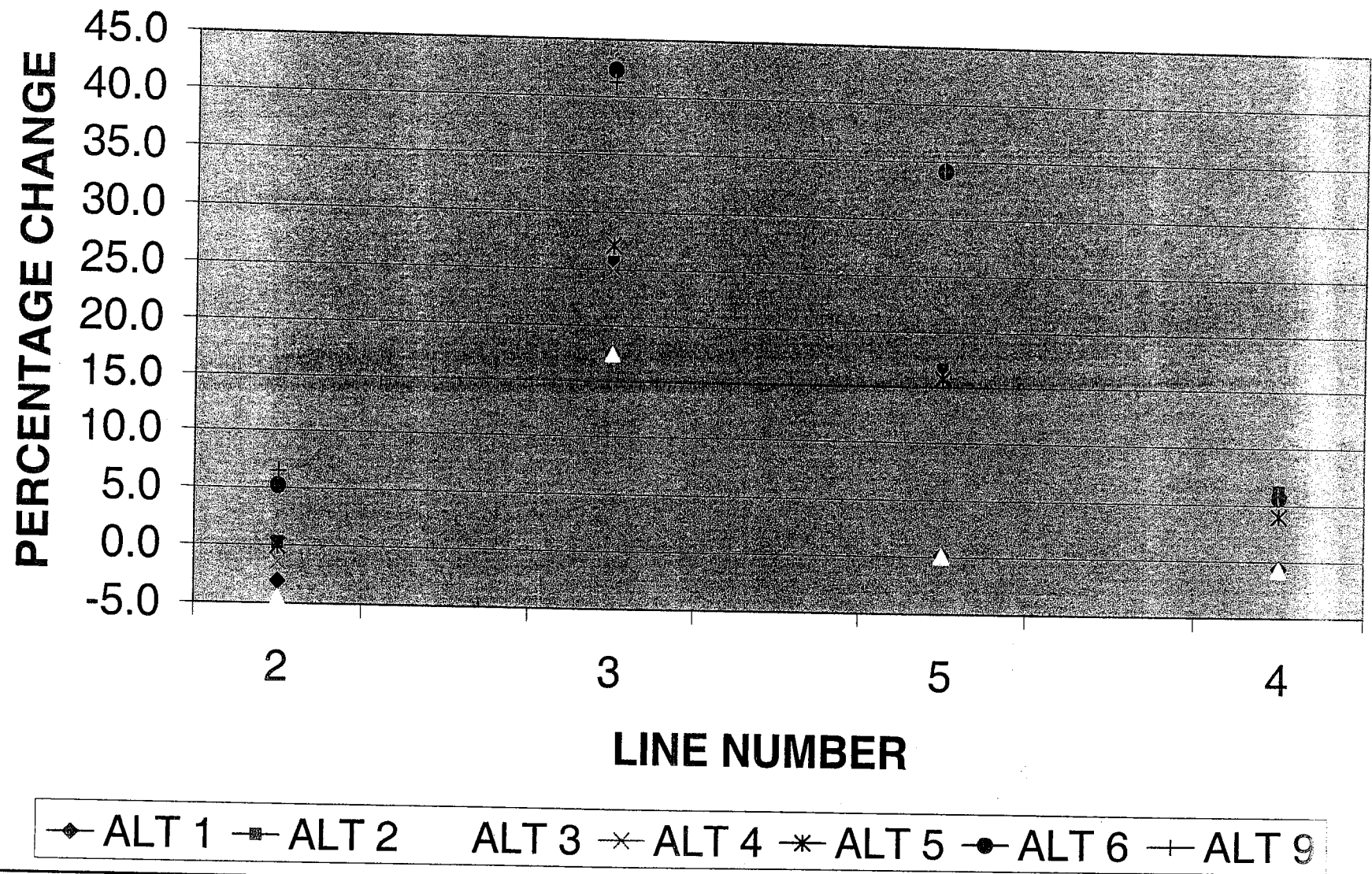


FIGURE 8. FLOOD CONVEYANCE PERCENT CHANGE

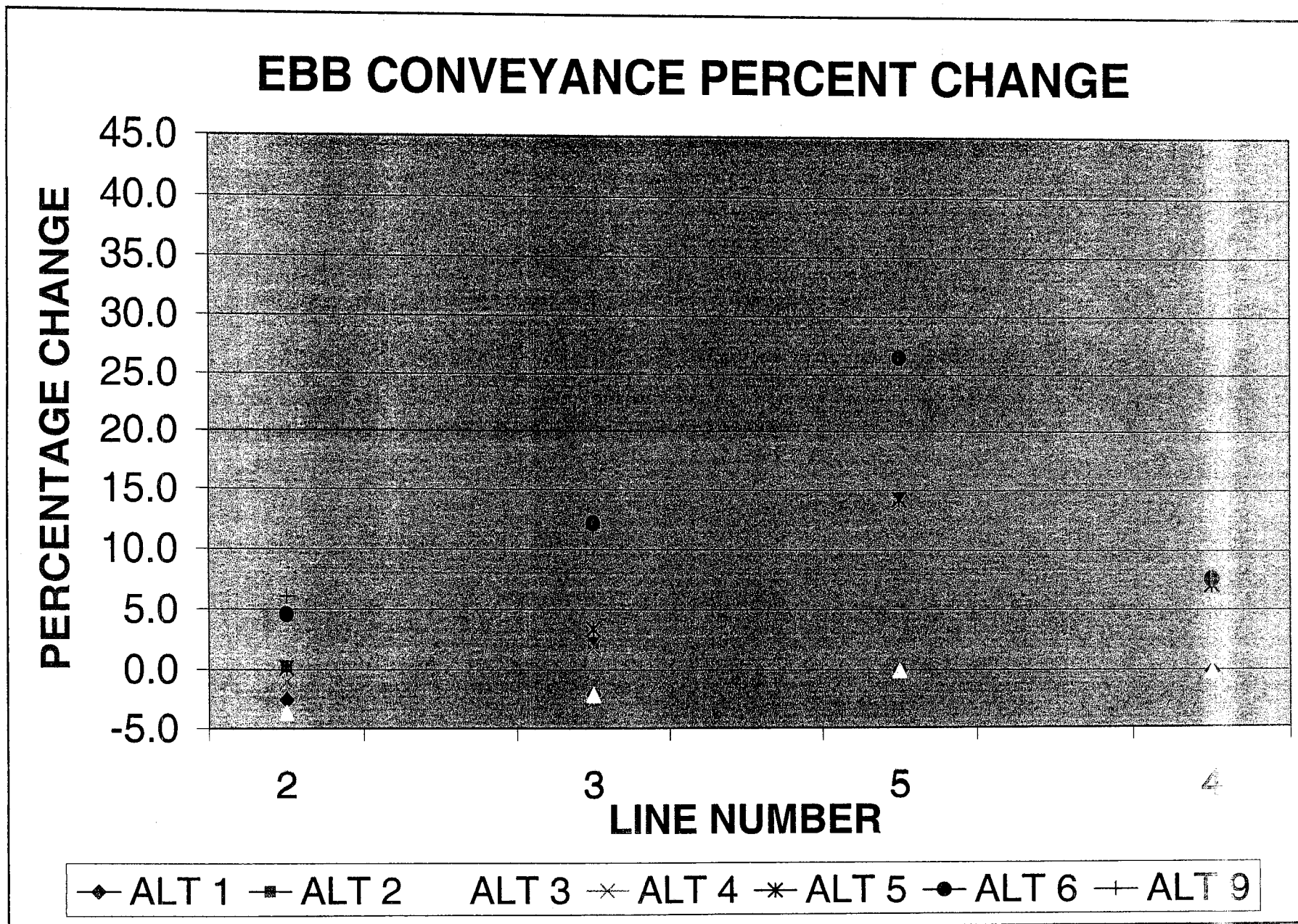


FIGURE 9. EBB CONVEYANCE PERCENT CHANGE

NORTH FORT HARRISON - WATER SURFACE, NGVD

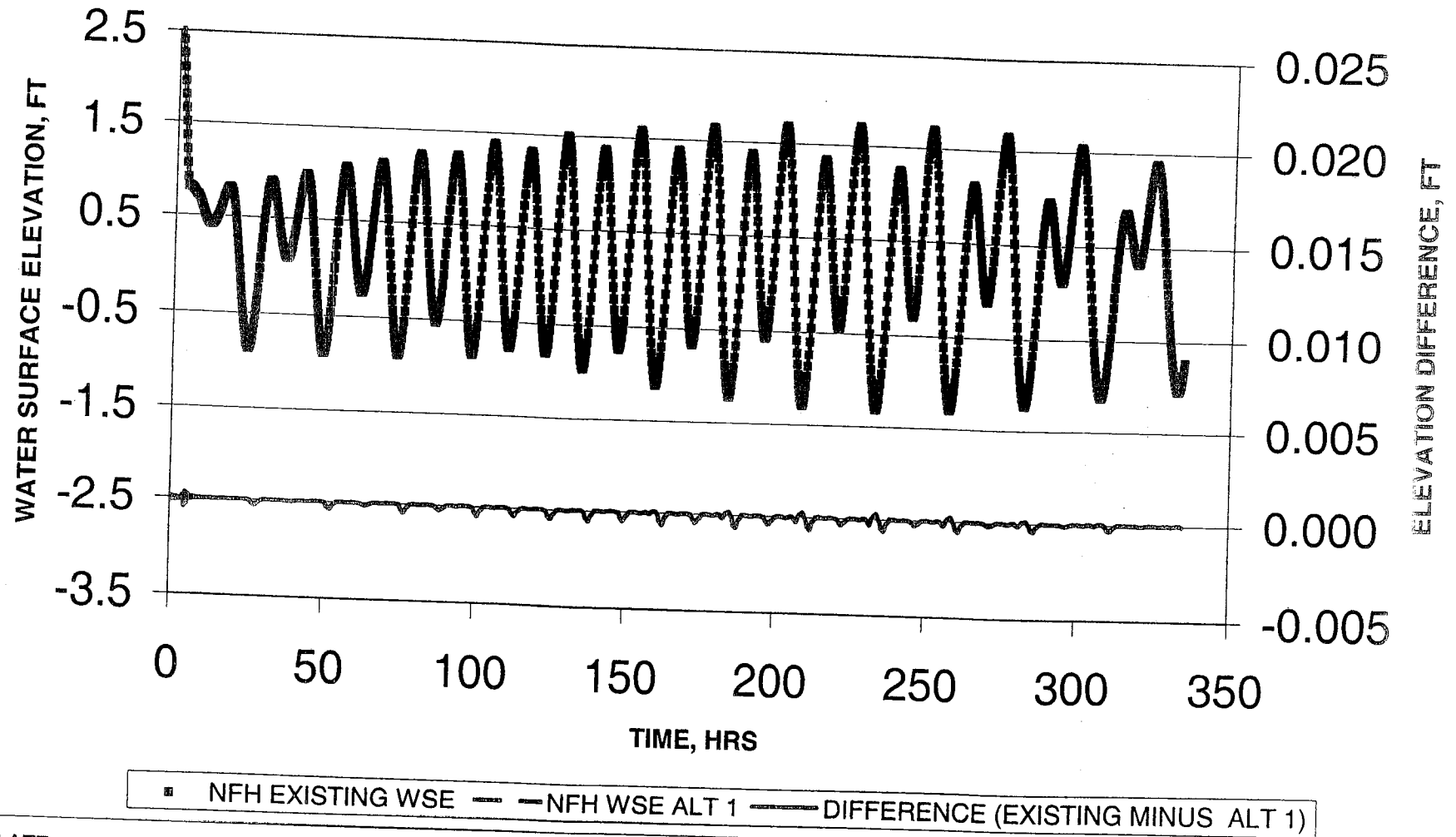


PLATE 1. WATER SURFACE ELEVATION & DIFFERENCE TIME HISTORY - HOURS 0 - 336 - ALTERNATIVE 1 - NORTH FORT HARRISON

NORTH FORT HARRISON - WATER SURFACE, NGVD

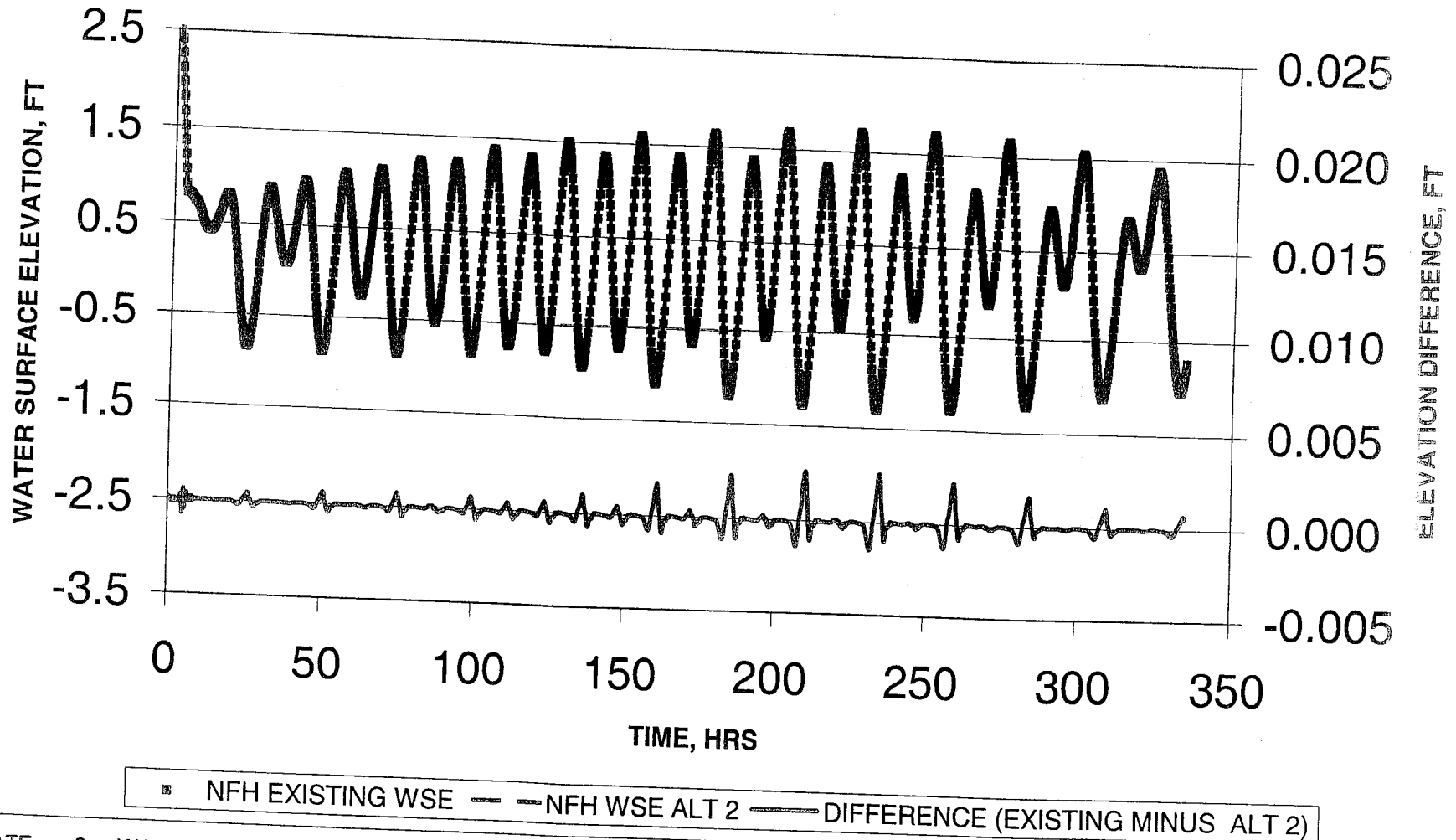
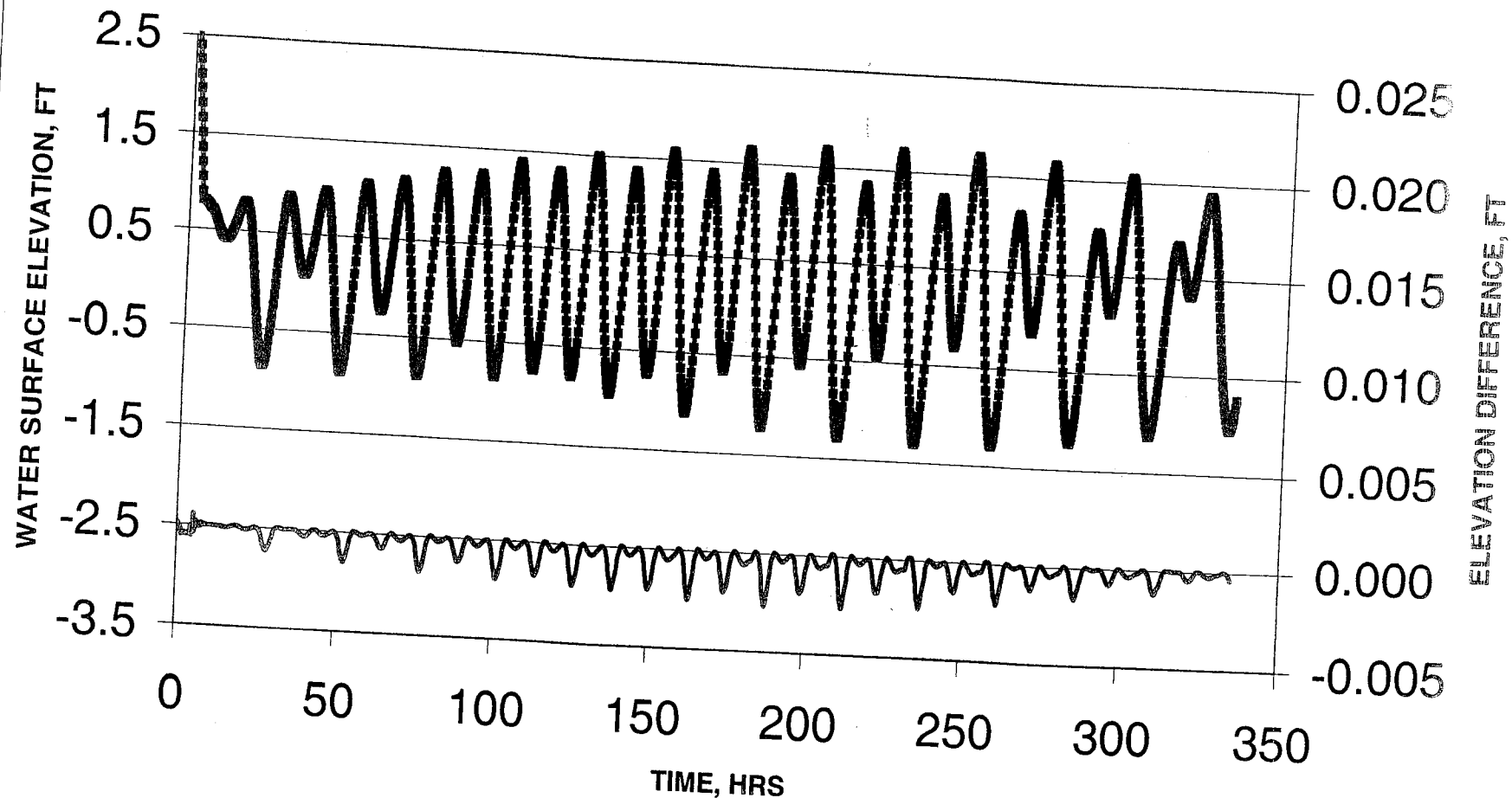


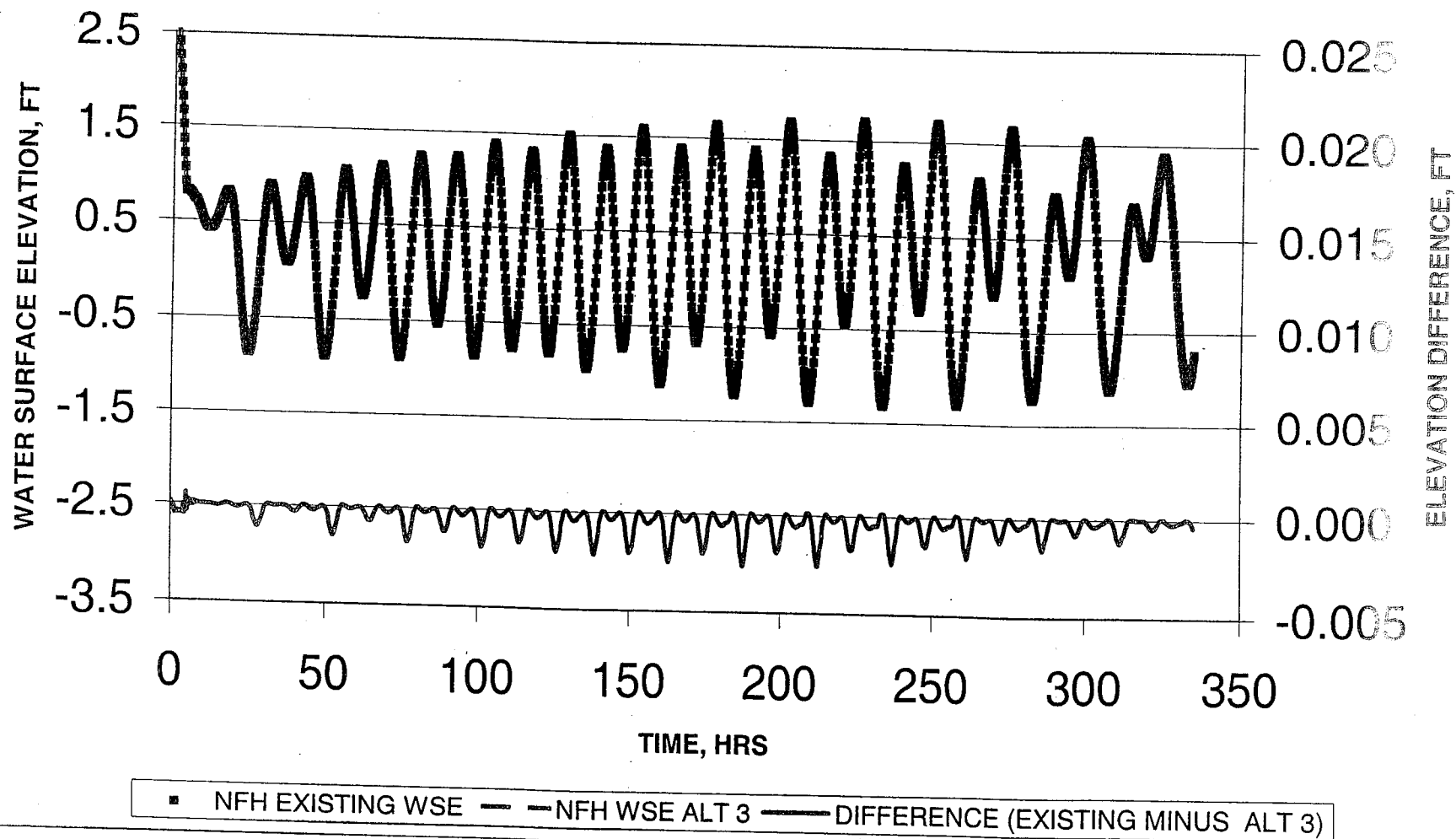
PLATE 2 . WATER SURFACE ELEVATION & DIFFERENCE TIME HISTORY - HOURS 0 - 336 - ALTERNATIVE 2 - NORTH FORT HARRISON

NORTH FORT HARRISON - WATER SURFACE, NGVD

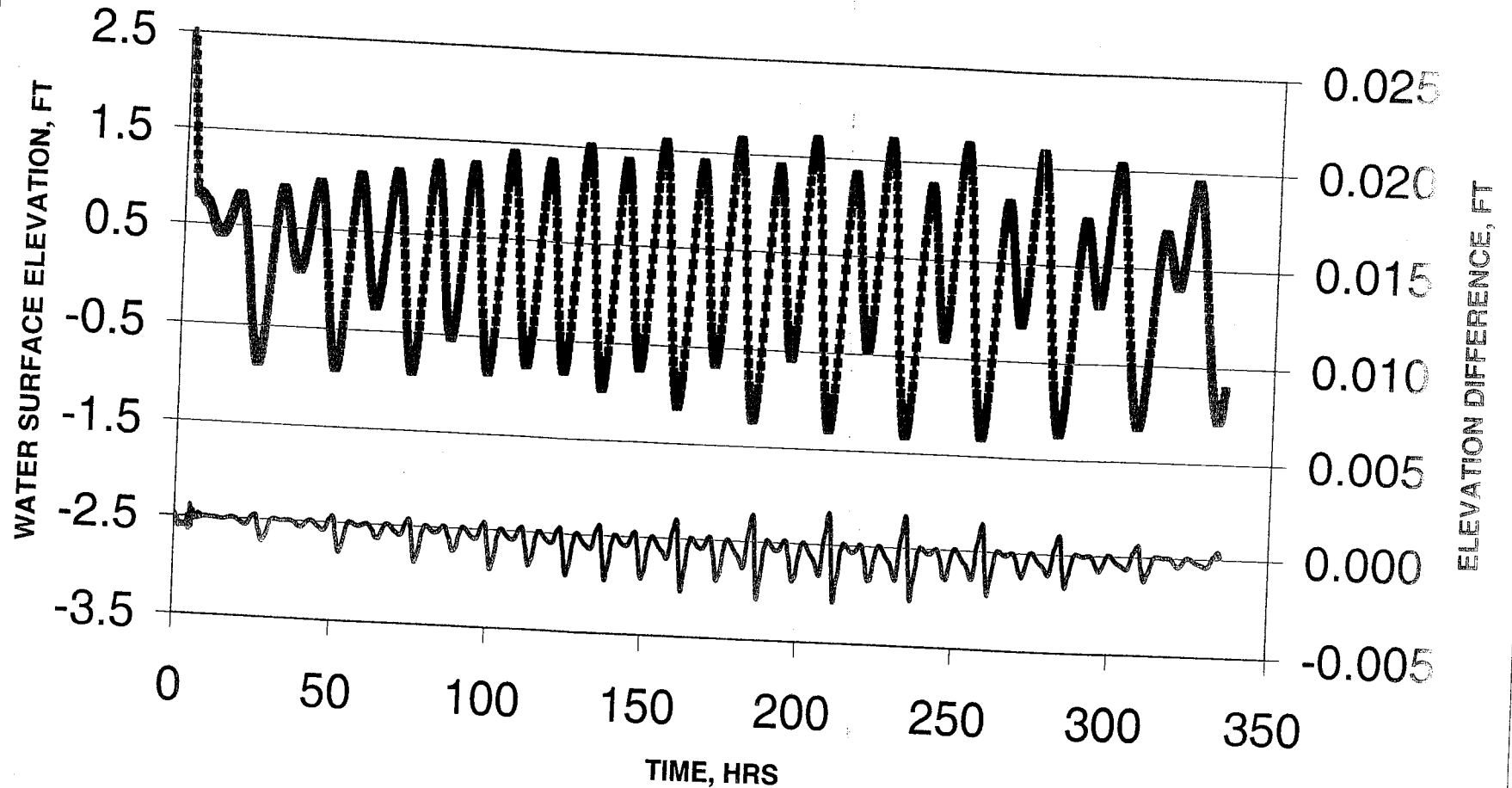


NFH EXISTING WSE
 NFH WSE ALT 3
 DIFFERENCE (EXISTING MINUS ALT 3)

NORTH FORT HARRISON - WATER SURFACE, NGVD

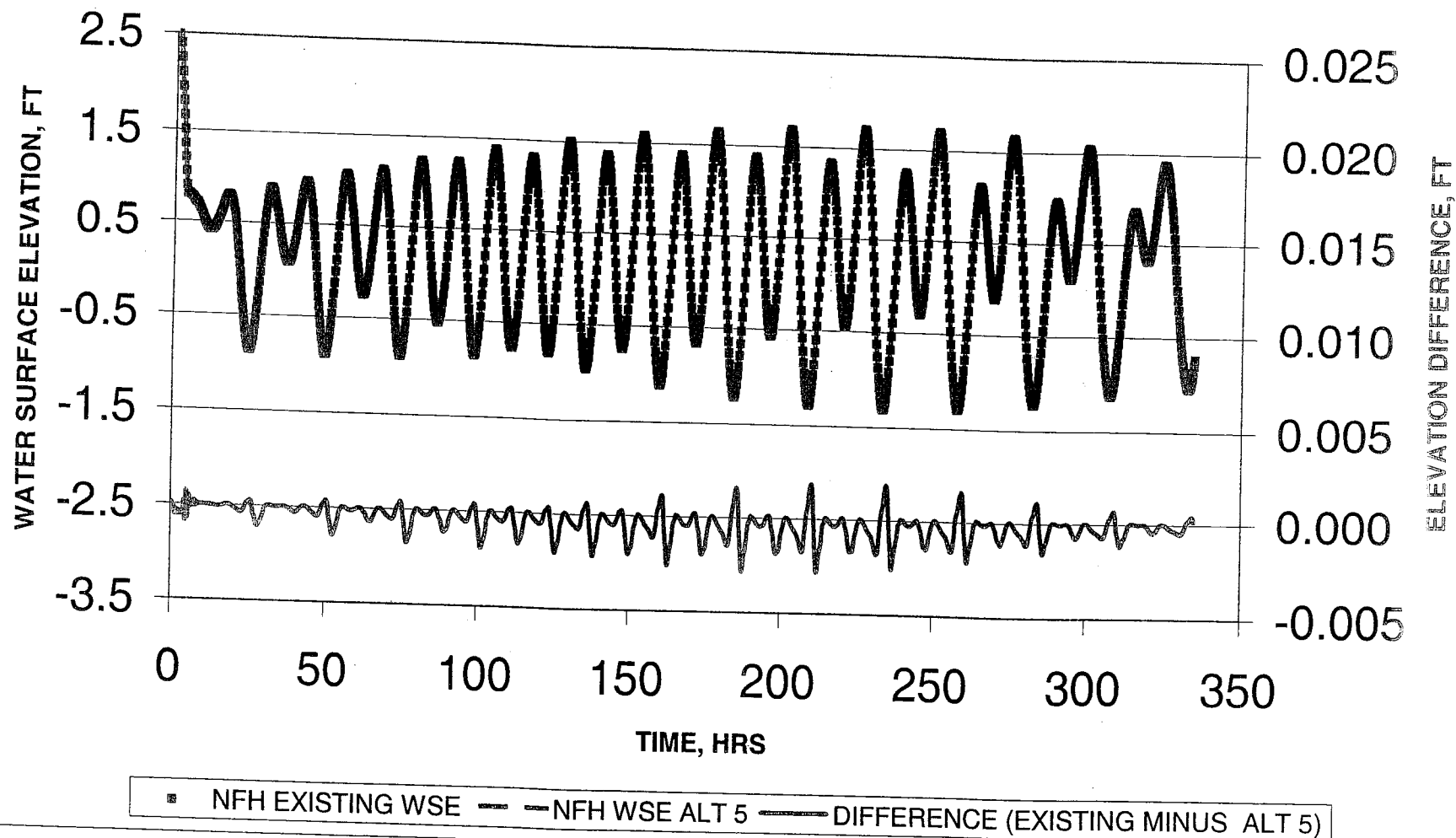


NORTH FORT HARRISON - WATER SURFACE, NGVD



■ NFH EXISTING WSE — — NFH WSE ALT 4 — — DIFFERENCE (EXISTING MINUS ALT 4)

NORTH FORT HARRISON - WATER SURFACE, NGVD



NORTH FORT HARRISON - WATER SURFACE, NGVD

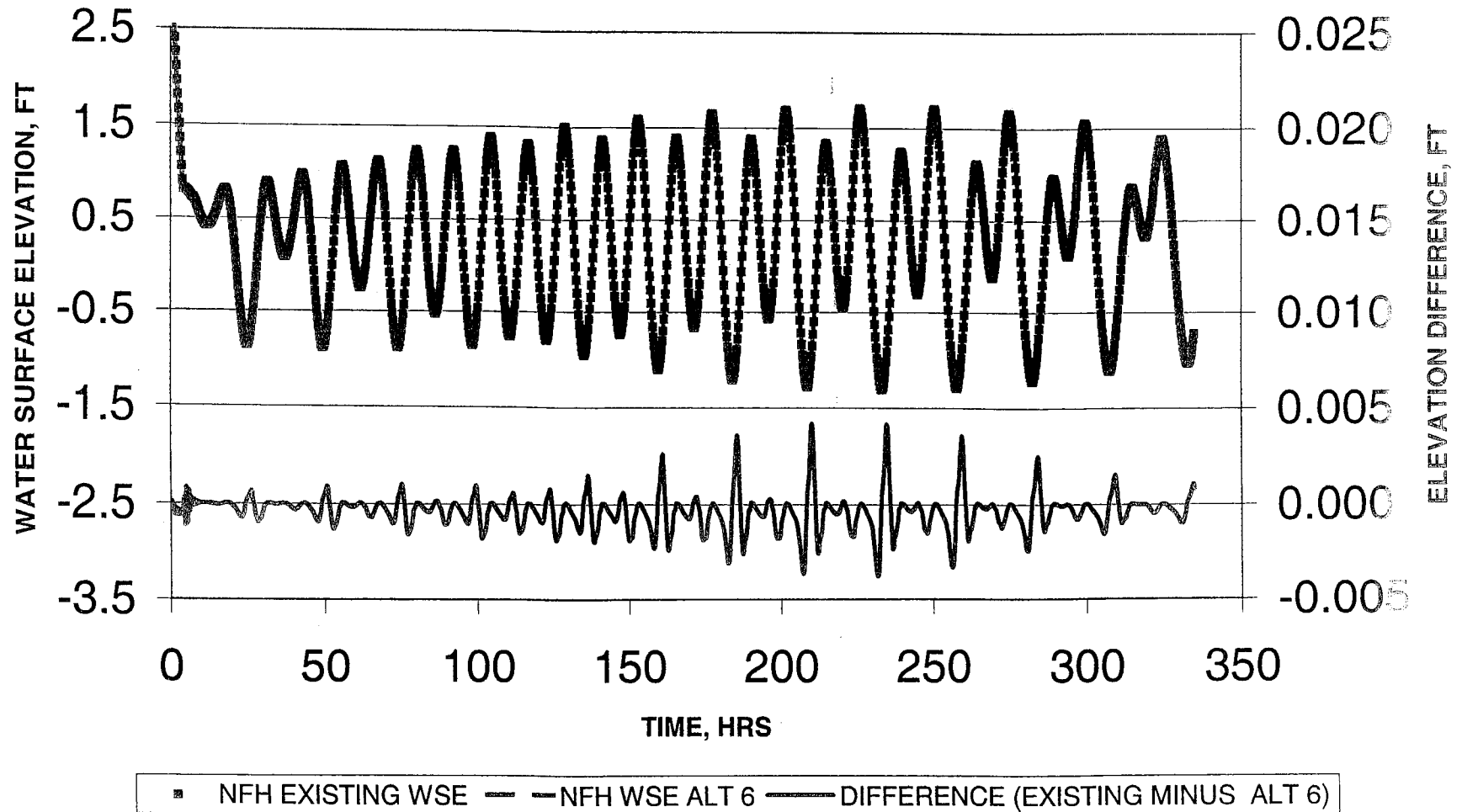
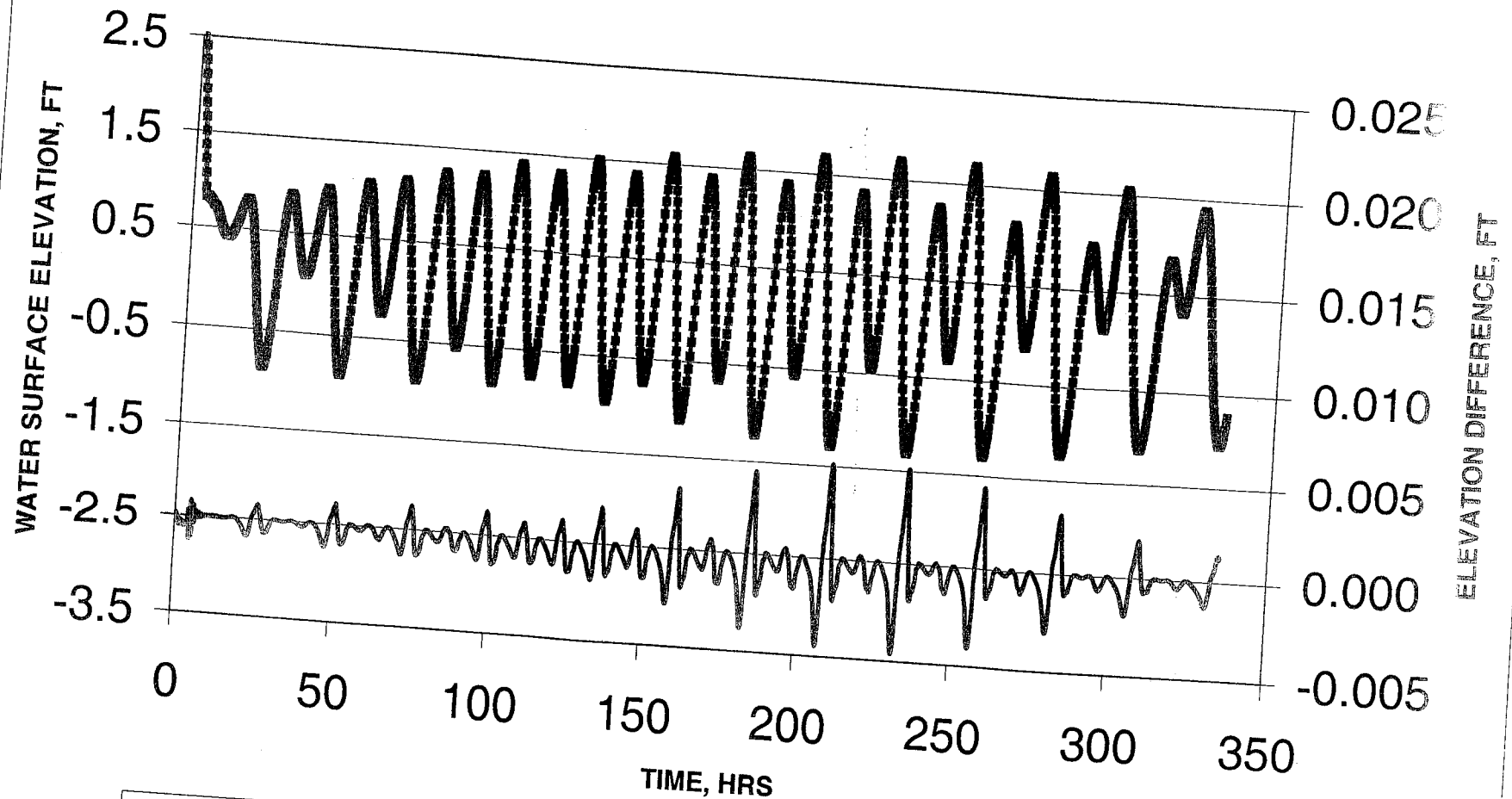


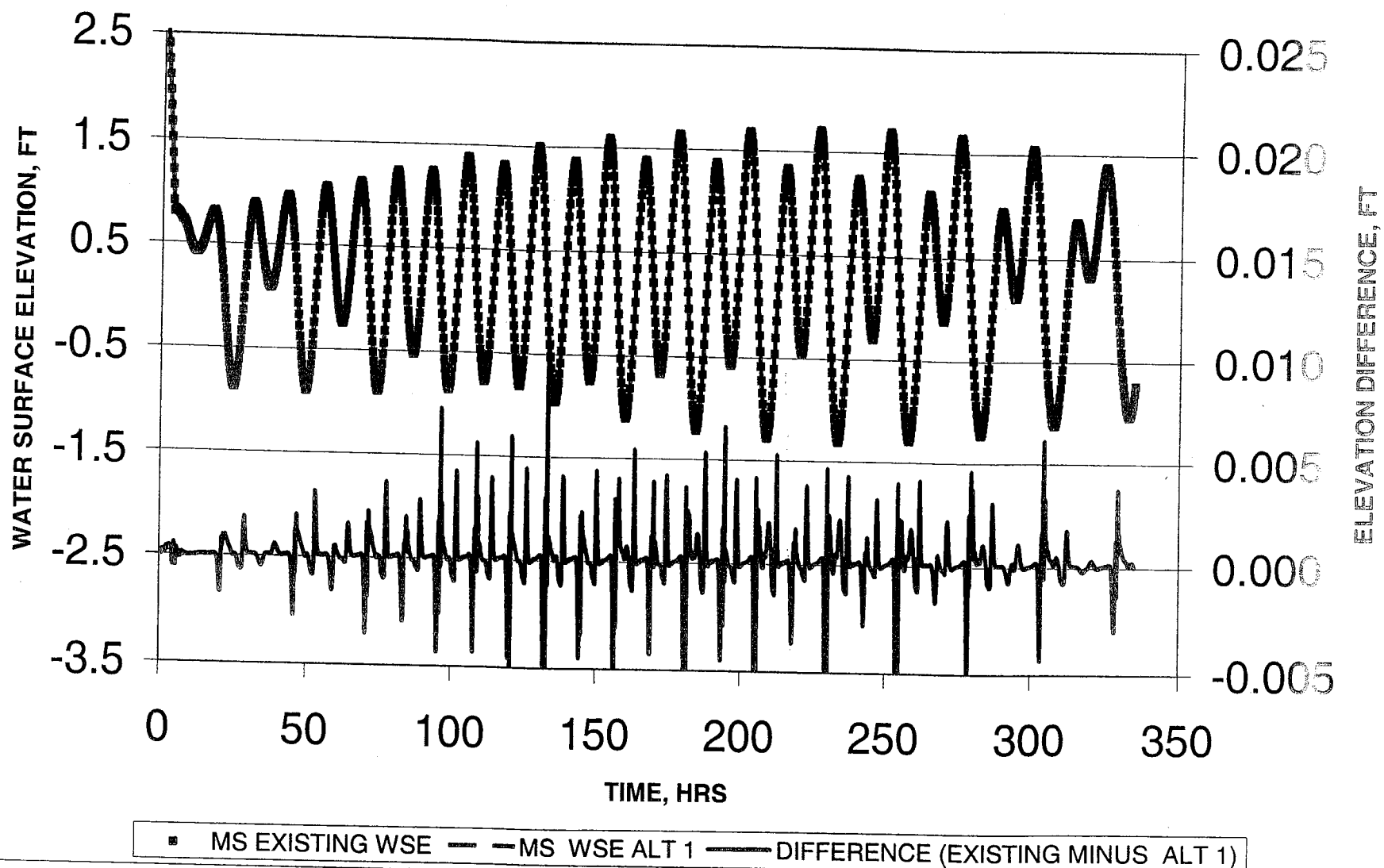
PLATE 6 . WATER SURFACE ELEVATION & DIFFERENCE TIME HISTORY - HOURS 0 - 336 - ALTERNATIVE 6 - NORTH FORT HARRISON

NORTH FORT HARRISON - WATER SURFACE, NGVD

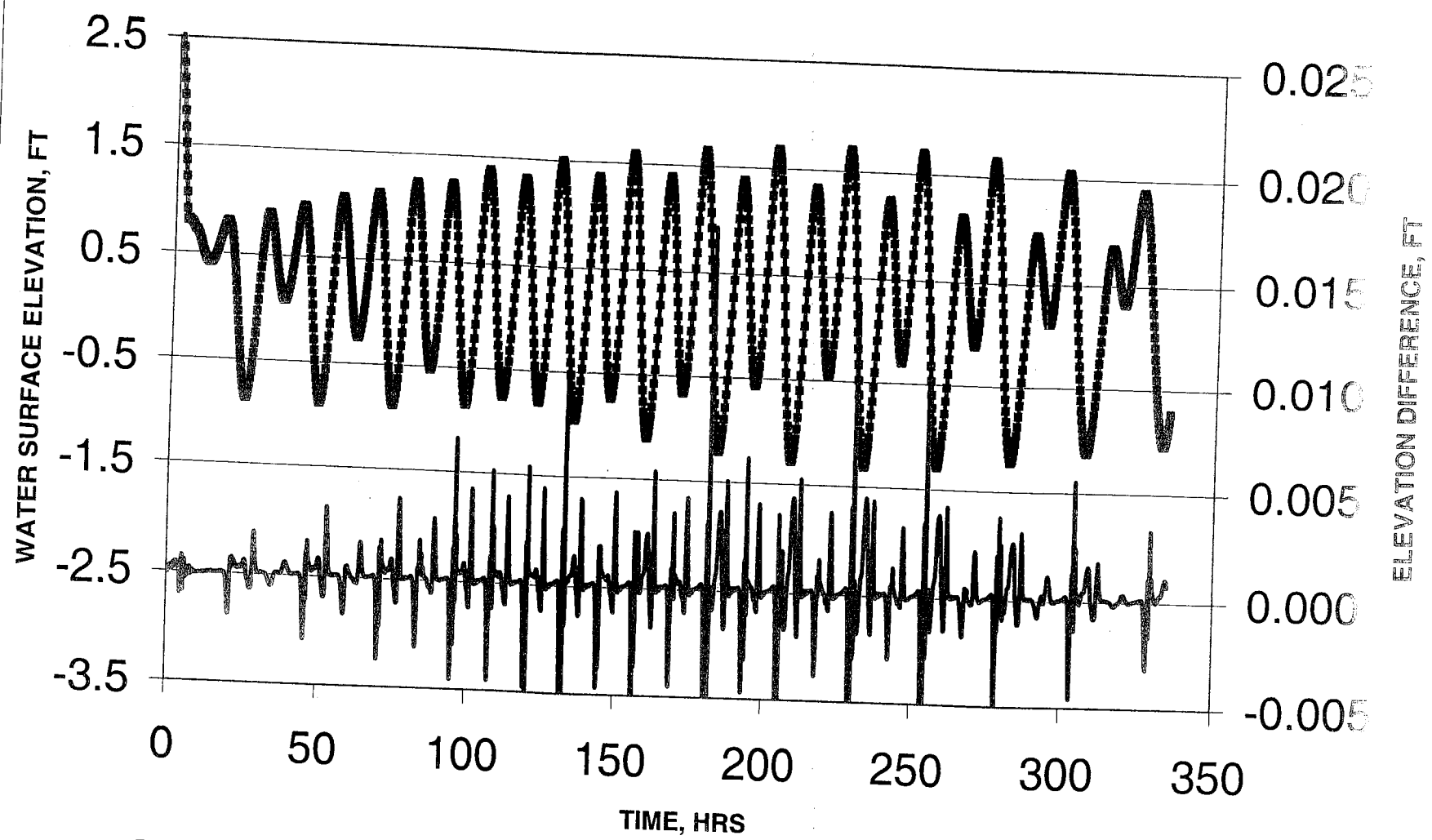


NFH EXISTING WSE
 NFH WSE ALT 7
 DIFFERENCE (EXISTING MINUS ALT 7)

MANGROVE SHELF WATER SURFACE, NGVD



MANGROVE SHELF WATER SURFACE, NGVD



■ MS EXISTING WSE - - - MS WSE ALT 2 ——— DIFFERENCE (EXISTING MINUS ALT 2)

MANGROVE SHELF WATER SURFACE, NGVD

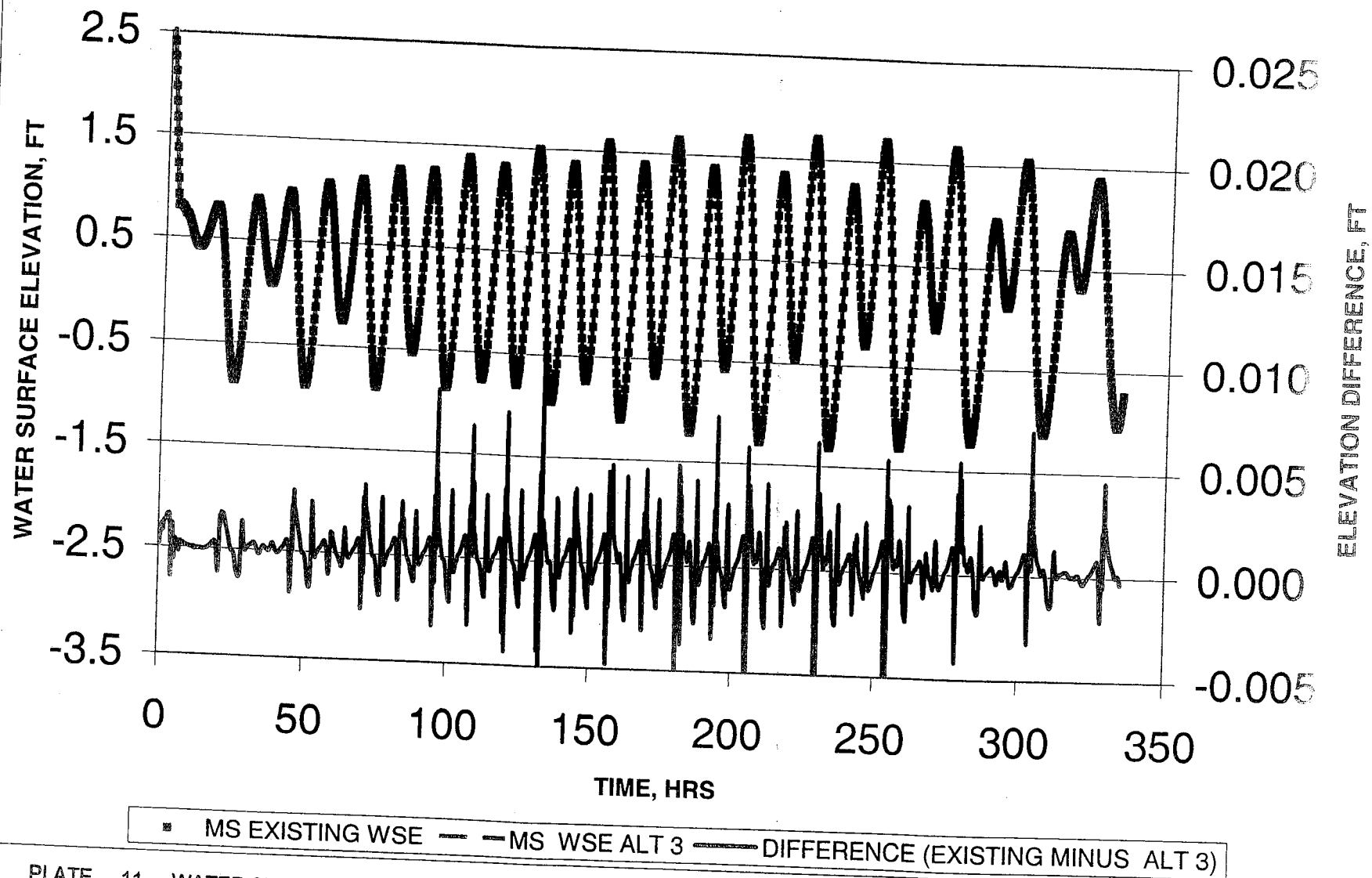
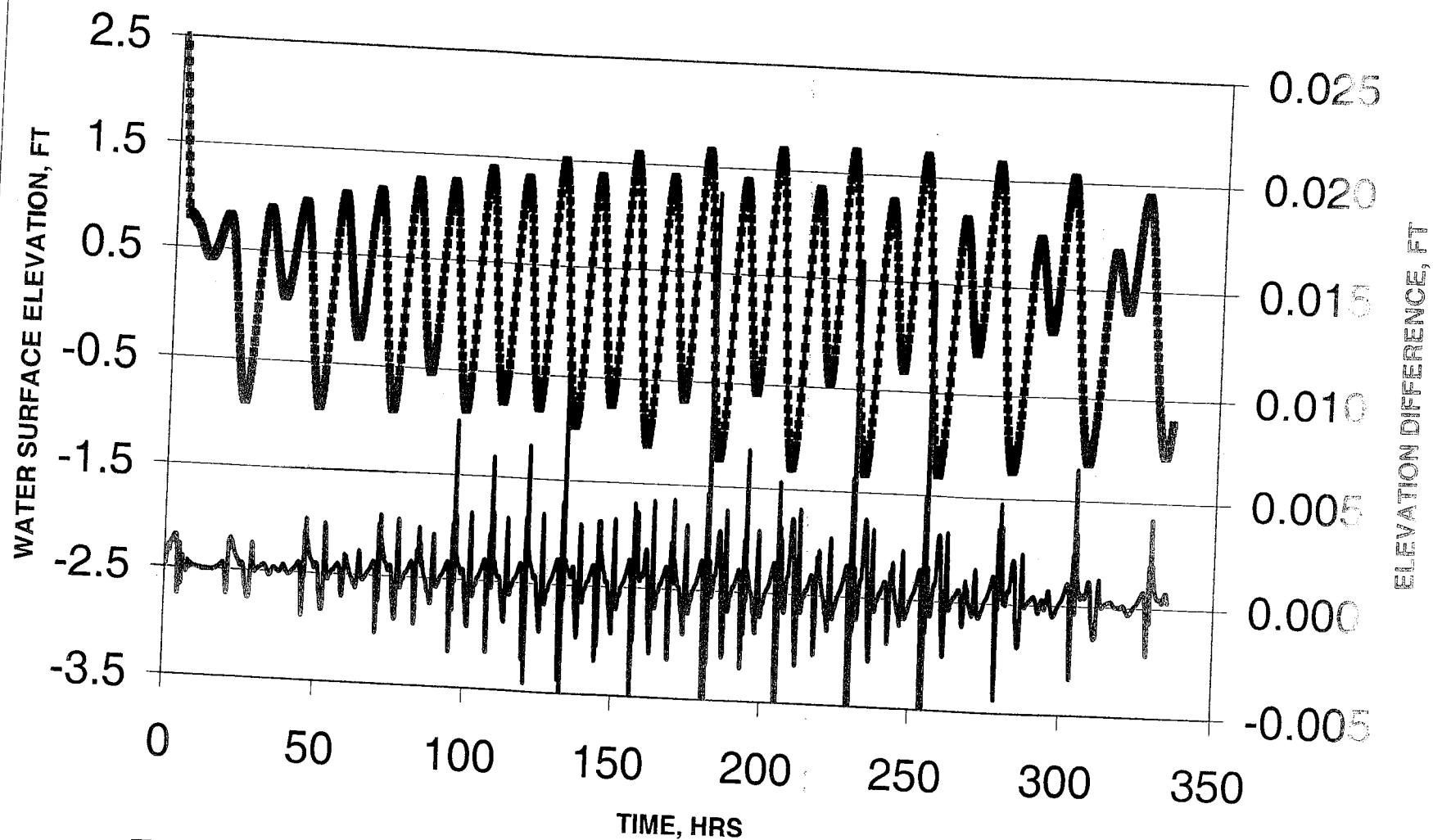


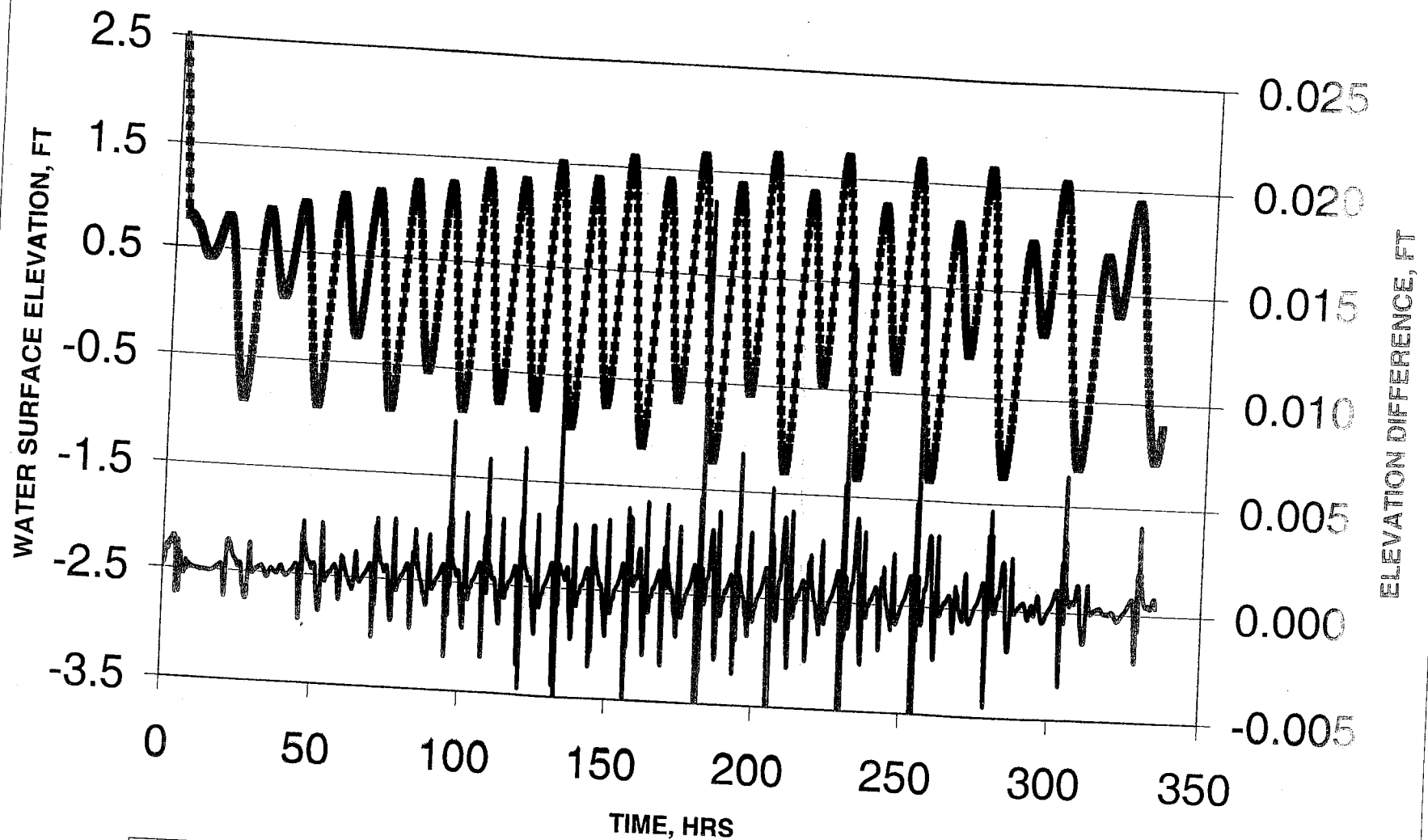
PLATE 11 . WATER SURFACE ELEVATION & DIFFERENCE TIME HISTORY - HOURS 0 - 336 - ALTERNATIVE 3 - MANGROVE SHELF

MANGROVE SHELF WATER SURFACE, NGVD



MS EXISTING WSE
 MS WSE ALT 4
 DIFFERENCE (EXISTING MINUS ALT 4)

MANGROVE SHELF WATER SURFACE, NGVD



■ MS EXISTING WSE — MS WSE ALT 5 — DIFFERENCE (EXISTING MINUS ALT 5)

MANGROVE SHELF WATER SURFACE, NGVD

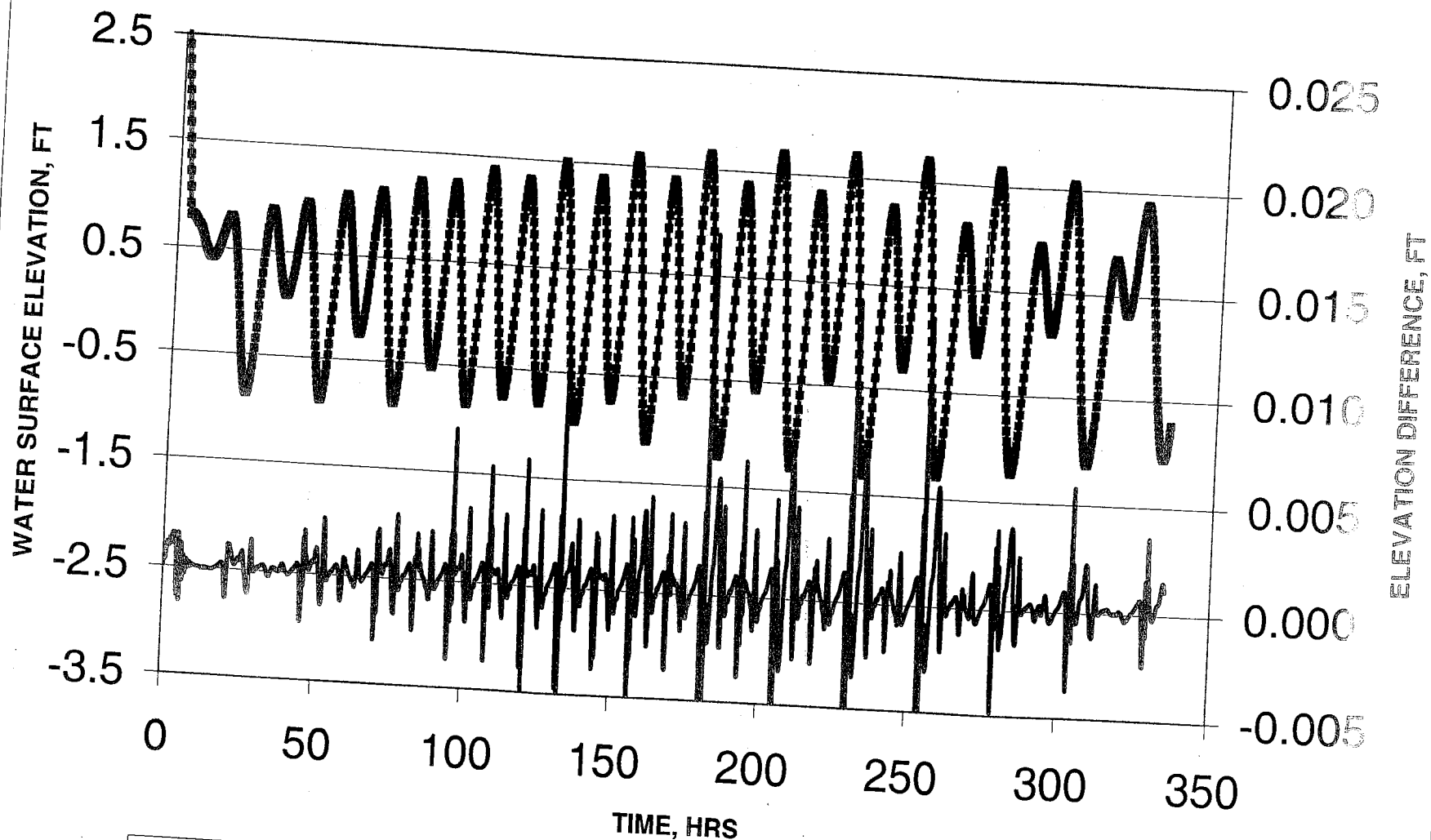
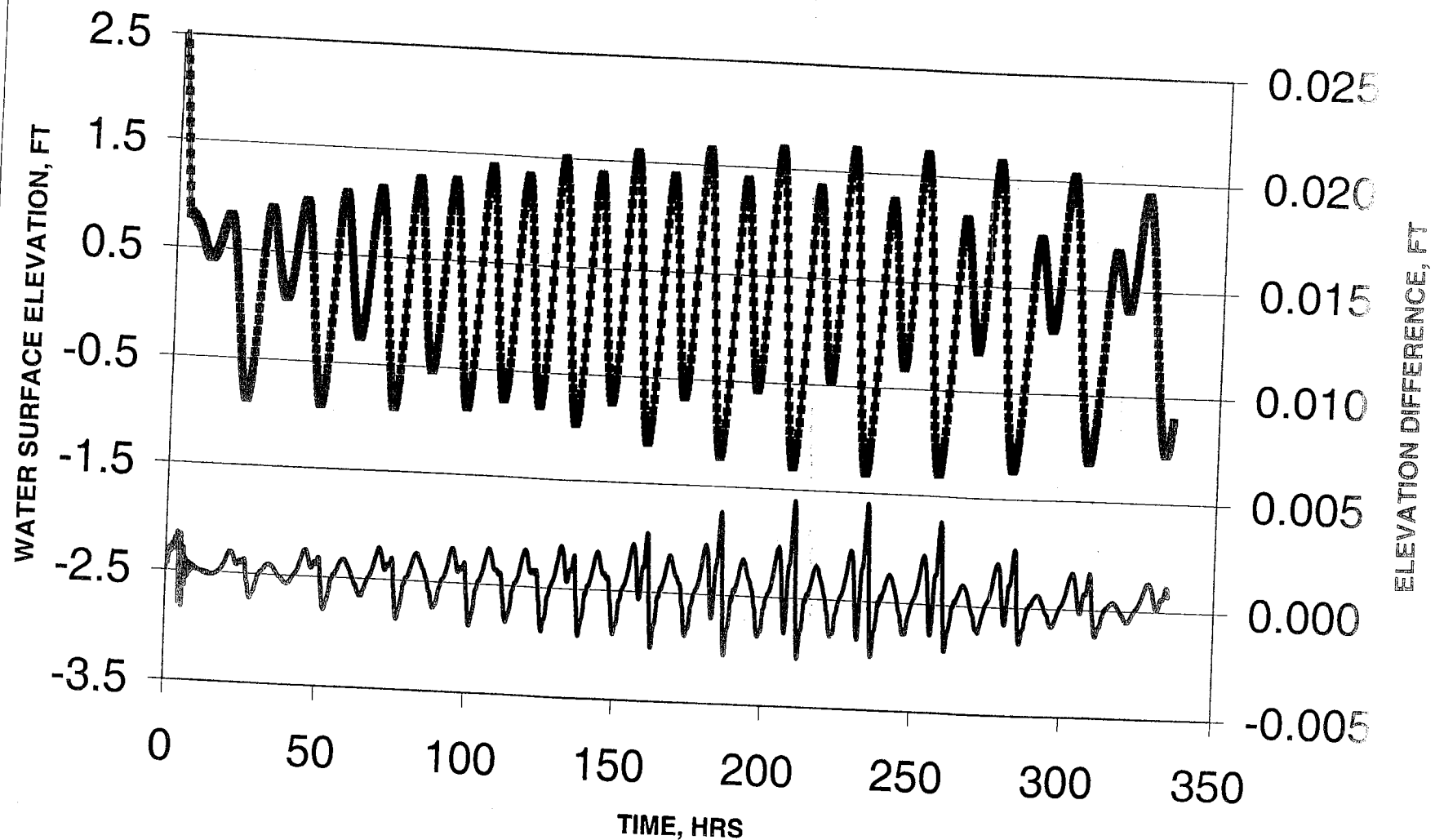


PLATE 14 . WATER SURFACE ELEVATION & DIFFERENCE TIME HISTORY - HOURS 0 - 336 - ALTERNATIVE 6 - MANGROVE SHELF

MANGROVE SHELF WATER SURFACE, NGVD



■ MS EXISTING WSE — MS WSE ALT 7 — DIFFERENCE (EXISTING MINUS ALT 7)

SHELF AREA - WATER SURFACE, NGVD

